DBF #372A028

TOWN OF BRIDGEVILLE

CONSTRUCTION STANDARDS
AND SPECIFICATIONS
FOR WATER, SEWER AND STREETS

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October 1995

Revised November 2005

REVISED FEBRUARY 2008

REVISED DECEMBER 2017

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GENERAL CONDITIONS

1. DEFINITION OF TERMS

A. Whenever in these documents, the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

"Town of Bridgeville"
Town of Bridgeville, Sussex County, Delaware.

"Engineer"
Consultant Engineer for the Town of Bridgeville or a duly authorized representative.

"Resident Project Representative"
An authorized representative of the Town or Engineer assigned to make any and all necessary observations of the work performed and materials and/or equipment furnished by the Contractor.

"Contractor"
Party responsible for constructing a utility or roadway, acting directly or through his agents or employees.

"Subcontractor"
Any individual, firm or corporation who contracts with a contractor to perform part or all of the latter's contract.

"Shop Drawings"
Drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor or any subcontractor, manufacturer, supplier or distributor, and which illustrate some portion of the work.

"Surety"
The body corporate, approved by the Town, which is bound with and for the Contractor who is primarily liable, and which engages to be responsible for his acceptable performance of the work for which he has contracted.

"Developer"
Person or persons contracting for work which will be connected to or made part of Town of Bridgeville utilities or roads system.

"Drawings"
All drawings or reproduction of drawings, pertaining to the work under the contract, which are furnished or approved by the Engineer or Town.

"Specifications"
The definitions, descriptions, directions, provisions and requirements, contained herein, and all written supplements thereto, made or to be made, pertaining to the contract, and the materials, equipment and workmanship to be furnished under the contract.

"Approved", "As Required", and similar expressions
Meaning shall be construed as "as approved by the Engineer" and "as required by the Engineer".

"General Conditions"
Provisions that establish and pertain to the legal responsibilities between the parties involved in the work, namely Town, Engineer and Contractor.

"Bond" or "Contract Bond"
The form of security to be approved by the Town of Bridgeville, furnished by the Developer and his Surety.

"Provide"
A direction to the Contractor to furnish all materials, equipment and labor and make payment for all of these necessary to complete the contract.

"Work"
Any and all things agreed to be furnished or done by, or on the part of, the Contractor, and which are required in the construction and completion of the project herein contemplated. Includes labor, material and equipment.

"Material" or "Materials"
Unless the context otherwise requires, these words or either of them, shall include equipment.

"Furnish"
A direction to the Contractor to supply and make payment for materials and equipment but not necessarily to install or pay workmen to install, or both, these items.

"General Conditions"
Provisions that establish and pertain to the legal responsibilities between the parties involved in the work, namely Town and Contractor.

B. Whenever, in the specifications and upon the drawings, the words DIRECTED, REQUIRED, PERMITTED, ORDERED, DESIGNATED, PRESCRIBED and words of the like import are used, it shall be understood that the directions, requirements, permissions, order, designation, or prescription of the Town is intended and similarly the words APPROVED, ACCEPTABLE, SATISFACTORY, and words of like import shall mean "approved by, or acceptable or satisfactory to the Town unless otherwise expressly stated".

2. PERMITS, FEES AND NOTICES

A. The Contractor or Developer shall pay taxes, royalties, and fees, and secure licenses that are required, during the time of the contract, by local, county, state and federal laws, ordinances, rules, codes and regulations for the legal performance of the contract. Impact fees or connection fees assessed by the Town shall be paid prior to start of any construction.

B. The Contractor shall perform the work in accordance with notices issued by public authorities having jurisdiction over the work including, but not limited to,

Delaware Department of Transportation, Delaware Department of Health and Social Services, and the USDA Soil Conservation Service.

C. If the Contractor performs work, knowingly or ignorantly, contrary to requirements of local, county, state and federal laws, ordinances, rules, codes and regulations, he shall assume full responsibility therefore and shall bear all costs of suits, actions and damages resulting from his illegal work performed.

3. INDEMNIFICATION OF THE TOWN

A. The Contractor and Developer shall indemnify and hold harmless the Town of Bridgeville and the Engineer, and all who represent them, from and against claims, damage, losses and expenses arising out of the Contractor's performance of the work, provided such claim, damage, loss and expense are attributable to:

(1) Bodily injury, sickness, disease or death, or injury to tangible property, including the loss of use resulting therefrom, and

(2) Negligence of the Contractor or his subcontractors and others directly related to the project or both.

4. UNAUTHORIZED WORK

Work performed without Engineer's approval of lines and grades, work performed beyond the lines and grades shown on the drawings or as given, except as herein provided, and extra work performed without written authority, will be considered as unauthorized and at the expense of the Contractor. Work so performed may be ordered by the Engineer removed and replaced at the Contractor's expense.

5. COOPERATION OF CONTRACTOR AND REPRESENTATIVE

The Contractor shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the Engineer and Town of Bridgeville. The Contractor shall have at all times a competent and reliable representative on the work, authorized to receive orders and act for him.

6. LAWS TO BE OBSERVED

The Contractor and Developer shall observe and comply with federal, state, county, and local laws, ordinances, rules, regulations, decrees and orders that are in effect and applicable to the work during the time of construction and he shall see that his subcontractors likewise, meet these requirements. He shall indemnify, and hold harmless, the Town and his representatives against claims and liabilities arising from Contractor and Subcontractor violations of such laws, ordinances, rules, regulations, decrees, and orders, whether such violations be by the Contractor or any Subcontractor, or any of their agents and/or employees.

7. LINES, GRADES AND ELEVATIONS

A. The Developer will indicate necessary bench marks and reference points, from which the Contractor shall lay out the lines, grades, and elevations of the work

and shall conform his work thereto.

B. The Contractor shall provide for approval by the Engineer, line and grade stakeout required for proper execution of the work as specified.

C. The Contractor shall furnish the Engineer, at least five days prior to the start of construction, two record copies of line and grade stakeout data for approval. The furnishing of such record data shall in no way release the Contractor from his responsibility for the completeness and accuracy of stakeout work necessary for construction.

D. All survey and stakeout work shall be done by qualified personnel subject to the approval of the Engineer.

E. All proposed sewer cleanouts and water meter assemblies shall be field located by the Contractor prior to the start of construction. Notice shall be given to the Town to observe the location and make any adjustments deemed necessary.

8. SANITARY PROVISIONS

The Developer's Contractor shall provide and maintain in a neat and sanitary condition such sanitary conveniences and accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Department of Health or of other bodies or tribunals having jurisdiction thereof. He shall commit no public nuisance.

9. PUBLIC CONVENIENCE

A. The Developer's Contractor shall conduct the work in a manner that will minimize obstruction to traffic in the area. The safety and convenience of the general public and of the residents and occupants of property along and adjacent to the work shall be provided in an adequate and satisfactory manner. Footways and portions of the highways and streams adjoining the work shall not be obstructed more than absolutely necessary. In no case shall any traveled thoroughfare be closed without permission of the Engineer.

B. Fire hydrants on or adjacent to the work shall be kept accessible to fire apparatus at all times, and no obstructions shall be placed within 15 feet of hydrant.

C. Gutters and storm drain inlets shall be kept unobstructed at all times.

10. SAFETY

In order to protect the lives and health of his or her employees, the Contractor shall comply with all pertinent provisions of the Contract Work Hours and Safety Standards Act, as amended, commonly known as the Construction Safety Act as pertains to health and safety standards; and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work, arising out of and in the course of employment on work under contract.

11. BARRICADES, DANGER, WARNING AND DETOUR SIGNS

The Developer's Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights, danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, on which shall be placed acceptable warning signs. The Contractor shall detour traffic and shall furnish and maintain all detour signs required to direct traffic over the entire route of the detour.

12. RESPONSIBILITY FOR WORK

Until the final acceptance of all the work shall be indicated in writing by the Engineer, the work shall be under the charge of and care of the Developer and his Contractor. They shall take every precaution against destruction of, injury, or damage to the work, or to any part thereof from any other cause whatsoever. The Contractor shall rebuild, repair, restore, and make good, at his own expense, all destruction of injuries or damage to the work or any of the above causes before its final completion and acceptance shall be indicated in writing by the Engineer.

13. SUBMITTALS

A. The Developer or his Contractor shall submit shop drawings, material certifications, samples and test reports to the Engineer.

B. At completeness of the project, before it is turned over to Town, and prior to testing, Contractor shall provide four sets of operating manuals of all equipment incorporated into the work. He shall provide spare parts, manuals, and test procedures in printed form to cover the scope of the project.

C. Contractor and manufacturer's representatives of all equipment utilized in the work shall meet at the project to assure proper start-up.

14. TEST OF SAMPLES OF MATERIALS

Tests of materials shall be made at the Developer's or his Contractor's expense, by a certified testing laboratory, in accordance with the officially approved methods as described or designated. The Town reserves the right to conduct verification testing at their expense. The Contractor shall cooperate with and assist the Town in taking samples and packing them for shipment to a laboratory.

15. QUALITY OF MATERIALS AND WORKMANSHIP

A. Materials and workmanship shall be of best possible quality and feasibility for the intended purpose, whether or not a brand name is specified. Materials shall be new and unused.

B. Representative preliminary samples of materials may be requested by the Engineer for examination or testing, or both. Materials may be further inspected by the Engineer during preparation and construction of the work; and materials found to be substandard will be rejected.

C. Contractor shall submit to Engineer samples of alternate materials that require laboratory testing. Such materials shall not be incorporated into the work until Engineer states, in writing, that materials meet requirements of the specifications.

16. AUTHORITY OF ENGINEER

The Engineer shall, in all cases, determine the amount or quantity, quality and acceptability of the work and materials. He shall decide on all questions in relation to said work and the performance thereof.

17. AUTHORITY AND DUTIES OF RESIDENT PROJECT REPRESENTATIVE

Resident Project Representatives (R.P.R.'s) employed by the Town or Engineer shall be authorized to observe all work done and materials furnished. Such observation may extend to all or any part of the work and to the preparation or manufacturer of the materials to be used. An R.P.R. may be stationed on the work to report to the Engineer as to the progress of the work and the manner in which it is being performed; also to report whenever it appears that the materials furnished and work performed by the Developer's Contractor fail to fulfill the requirements of the specifications and contract. No inspection, or any failure to inspect, at any time or place, however, shall relieve the Contractor from his obligation to perform all the work strictly in accordance with the requirements of the specifications. The R.P.R. shall perform such other duties as are assigned to him. He shall not be authorized to revoke, alter, enlarge, relax or release any requirements of these specifications, nor to approve or accept any portion of work, nor to issue instruction contrary to the drawings and specifications. The R.P.R. shall in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the work by the latter.

18. INSPECTION OF MATERIALS AND WORK

The Developer's Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether or not the work, as performed, is in accordance with the requirements and intent of the specifications and contract. If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove and/or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove unacceptable, the removing, replacing and/or making good the parts removed shall be the Contractor's expense.

19. DEFECTIVE MATERIALS AND WORK

All materials not conforming to the requirements of these specifications shall be considered as defective, and all such materials whether in place or not, shall be rejected and shall be removed immediately from the work unless otherwise permitted. No material which has been rejected, the defects of which have been corrected or removed, shall be used until approval has been given. All work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the Developer's Contractor at his own expense.

20. FAILURE TO REMOVE AND RENEW DEFECTIVE MATERIALS AND WORK

Should the Developer's Contractor fail or refuse to remove and renew defective

materials used or work performed previously or to make any necessary repairs in an acceptable manner, and in accordance with the requirements of these specifications, within the time indicated in writing, the Engineer shall have the authority to cause the unacceptable or defective materials or work to be removed and renewed or such repairs to be made at the Developer's expense. Expenses incurred by the Town in making these removals, renewals, or repairs, which the Contractor has failed or refused to make, shall be paid by the Developer or may be charged against the "Performance Bond" or other deposit.

21. CLEAN-UP

A. The Developer's Contractor shall, at his own expense, keep the sites of his operations clean during construction and remove all rubbish as it accumulates.

B. Upon failure of the Contractor to keep the sites of his operations clean to the satisfaction of the Town, the Town may, upon 24 hours notice to the Contractor, remove rubbish, as is deemed necessary, and charging the cost thereof to the Developer.

C. On or before the completion of the work, the Contractor shall, without charge therefore, tear down and remove all his buildings and temporary structures built by him, shall remove all rubbish of all kinds from any grounds which he has occupied, and shall leave the site of the work in a clean and neat condition.

22. TEMPORARY SUSPENSION OF WORK

The Engineer shall have the authority to suspend the work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the suitable execution of the work, or for such time as is necessarily due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract documents. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent destruction, damage or deterioration of the work performed, provide suitable drainage by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The Contractor shall not suspend the work without authorization. Neither the failure of the Engineer to notify the Contractor to suspend the work on account of bad weather or other unfavorable conditions, nor permission by the Engineer to continue work during bad weather or other unfavorable conditions, shall be a cause for the acceptance of any work which does not comply in every respect with the contract and specifications.

23. GUARANTEE

The Developer hereby guarantees all of the work for a period of one (1) year after the date of completion and final acceptance thereof by the Town as follows:

A. Against all faulty materials and against all imperfect, careless and unskilled workmanship.

B. That the entire equipment and each and every part thereof shall operate (with

proper care and attention) in a satisfactory and efficient manner, and in accordance with the requirements of these contract documents.

C. That all structures shall be watertight and leak proof at every point and in every particular.

D. The Developer agrees to replace, with proper workmanship and materials, and to reconstruct, correct or repair, without cost to the Town, work which is improper, imperfect, does not operate in a satisfactory manner or fails to perform as specified, or all of these.

E. No use or acceptance by the Town of Bridgeville of the work or any part thereof, nor any failure to use the same, nor any repairs, adjustments, replacements or corrections made by the Town due to the Developer's failure to comply with his obligations, shall impair in any way the guarantee obligations assumed by the Developer under these documents.

F. It is understood and agreed that in the event the Developer fails to correct or repair any work under the contract which may be found to be improper or imperfect or otherwise fails to fulfill the terms of the Guarantee, the Town may purchase materials, tools and equipment and employ labor, or let a contract as required perform the necessary corrective work by the Town, shall be charged against the Performance Bond.

24. SHOP DRAWINGS

A. The Developer or his Contractor shall furnish shop drawings for all fabricated construction materials required for the work, unless otherwise directed by the Engineer. Furnish six (6) copies of each shop drawing for Engineer's approval. The Contractor shall not order materials until receiving shop drawing approval.

B. Regardless of corrections made in or approval given to shop drawings by the Town, the Contractor will nevertheless be responsible for the accuracy of such drawings and for their conformity to the plans and specifications, unless he or she notifies the Town in writing of any deviation at the time he or she furnishes such drawings. Only drawings bearing the approval stamp of the Town shall be used for ordering materials or for construction.

25. COOPERATION WITH OTHER CONTRACTORS

A. The Contractor and Developer shall cooperate with and so conduct his operations as not to interfere with or injure the work of other contractors or workmen employed by the Town. He shall promptly make good, at his own expense, any injury or damage which may be done by him or his employees or agents on the work.

B. The Contractor shall suspend such part of the work herein specified, or shall carry on the same in such manner, as may be ordered by the Engineer when necessary to facilitate the work of such other contractors or workmen.

26. AS-BUILT PLANS

The Developer shall deliver, upon completion of construction, one (1) set of as-built drawings showing actual construction. Utility lines shall be shown with stations and measured locations to all manholes, cleanouts, laterals, meters, etc.

27. WORK AFFECTING DELAWARE D.O.T. JURISDICTION

A. All materials and construction methods for work affecting Delaware Department of Transportation jurisdiction shall be done in complete accordance with permit and/or franchise stipulations or directives issued by same. All costs for such work shall be the responsibility of the Contractor. The Developer shall supply all information requested by the Town to make application on his behalf.

B. Maintenance of traffic shall be accomplished in full accordance with the Delaware DOT publication, "Traffic Controls for Street and Highway Construction and Maintenance Operations", latest edition. Work in DOT Right-of-Way shall not commence without an approved signing plan.

28. PROJECT INSPECTION BY THE ENGINEER

The Town of Bridgeville shall, based on size and scope of a project, require inspection by the Town Engineer on construction activities. Inspection may include the following:

A. Supplement Public Works Department inspection.

B. Part time inspection by R.P.R.

C. Full time inspection by R.P.R.

Prior to issuance of a building permit, the Town shall advise the Developer of inspection requirements for the proposed project. The Developer shall pay all costs for inspection and shall deposit all estimated costs for same with the Town prior to the start of any construction. Not withstanding notice by the Town, the Developer is responsible for all cost of inspection which may be required during the course of the construction as determined by the Town.

29. DESIGN PARAMETERS

Section 1 of these standards provide requirements for design of water, sewer and road systems. These provisions shall not preclude requirements of the State of Delaware Department of Natural Resources and Environmental Control, the Division of Public Health the Delaware Department of Highways and Transportation. The Developer's Engineer shall conform to the more stringent requirements. He shall also obtain all permits required by the State.

30. LOCATION OF EXISTING UTILITIES

A. The Contractor shall contact "Miss Utility" at (800) 282-8555 at least 48 hours prior to digging in the vicinity of existing underground utilities to have them located and marked. It shall then be the Contractor's responsibility to verify these utilities, by test pits, a minimum of fifteen (15) days in advance of actual

construction operations in the vicinity of the utilities.

B. The failure to show on the contract documents any existing utilities shall not relieve the Contractor of his or her responsibilities of determining the location of these utilities, and any damage to the utilities or interruption of service shall be repaired by the Contractor according to the Town or utility company specifications. The Town shall be notified of any damage to any utilities.

31. ABANDONMENT/DEMOLITION OF PROPERTIES

Any existing building currently served by water/sewer, which is to be moved, demolished or permanently abandoned, shall leave the utility service lines abandoned in the manner outlined below at the Owners expense.

A. Water

Remove existing water meter and cap service line by Town approved contractor at Owners expense. Meter is to be returned to Town.

B. Sewer

Install clean out, if not already present, at property line with mechanical plug by Town approved contractor at Owners expense.

Town may request abandonment of services at respective main if no redevelopment potential of the property exists.

END OF SECTION

SECTION 1

DESIGN PARAMETERS

SECTION 1A - DESIGN PARAMETERS FOR WATER DISTRIBUTION SYSTEMS

1.01 GENERAL

Where existing primary mains are to be extended for a residential or commercial development, the Developer is responsible for tapping or connecting existing mains for extension purposes. Developer shall hire a Contractor approved by the Town of Bridgeville and pay all costs with the extension. The Developer is also responsible for installation of all service lines within the development inclusive of curb stops or meter assemblies as directed.

1.02 PROJECT DRAWINGS

The Developer and his Engineer are responsible for preparation of detailed drawings. These drawings must be approved by the Town Engineer.

A. Title Sheet

1. Title of Project and Address.
2. Phase of Project if necessary.
3. Developers' Name and Address.
4. Design Engineers Name and Address.
5. Drawing Index.
6. Approval Block for Town Engineers signature and date.
7. Vicinity Map showing location of Project within the Town.
   Typical scale shall be one inch equals 1000 feet.
8. Location Map if drawings are for one phase of the development.
9. Design Engineers Seal and Signature.
10. Certification by the Design Engineer to the accuracy of the drawings.
11. Certification by the Developer approving the drawings.

B. Horizontal Plan (Water Mains)

1. The scale shall be 1 inch equals 20 feet for small projects up to a maximum of 1 inch equals 40 feet for large projects. Profiles to be 1 vertical for each 10 horizontal scale.
2. North Arrow shall be shown.
3. The existing and proposed legend.
4. All necessity utility notes.
5. Location, elevation and description of all the Project Bench Marks.
6. Location and sizes of all proposed water lines with stations.
7. Locations of proposed valves, fittings, and fire hydrants.
8. Property lines and Township, with details of easements where required.
9. Location of all proposed structures and buildings.
10. Beginning and end of proposed construction.
11. Locations of proposed service lines.
12. Location of all other drainage facilities and public utilities.
13. Location of all existing water mains, valves, hydrants, services, etc.

C. Details (Water Mains)

Standard Construction Details as shown in the Standard Detail Section of this Booklet shall be included on the drawings where applicable.

1.03 DESIGN CAPACITY

A. Water Mains

In determining the required size and capacity of the water main, the following factors should be considered.

1. Estimated average and maximum water demand for the design period.
2. Topography of area.
3. Depth of excavation.
4. Fire fighting requirements.
5. Number of proposed services.
6. The calculations for design of the water mains shall accompany the Project drawings, when submitted to the Town Engineer for review when requested.

B. Water Service Lines

Individual water services shall be installed to each lot of a subdivision including separate corporation stop, meter, etc. Each unit of a townhouse, apartment, condominium, office complex and retail facility shall have a separate meter. Gang meters are acceptable. Service lines sizes shall be designed by the developer for the use intended. Minimum standards shall include the following:

	Min. Service Size	Min. Meter Size (Each Unit)
Single family residence (standard dual pit)	1”	5/8" x 3/4"
Duplex residence or double lot	2”	5/8" x 3/4"
4 unit apartment, condominium or townhouse (gang service)	2”	5/8" x 3/4"
8 unit apartment, condominium or apartment (gang service)	2"	5/8" x 3/4"

1.04 DESIGN SIZE

A. Pressure

All water mains shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 22 psi at ground level at all points in the distribution system under all conditions of flow.

B. Diameter

The minimum size of water main for providing fire protection shall be 6-inch diameter. Larger mains will be required, if necessary, to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure.

C. Small Mains

Any departure from minimum requirements shall be justified by hydraulic analysis and future water use and can be considered only in special circumstances.

1.05 DEPTH OF WATER MAINS

Minimum depth of water mains shall be 3'-6" as measured from the top of the pipe to finished grade.

1.06 VALVES

Sufficient valves shall be provided on the water mains for isolation during repairs. Valves should be located at not more than 500 foot intervals in commercial districts and at not more than one block or 800 foot intervals in other districts. Also, valves shall be placed at all main branch connections.

1.07 HYDRANTS

Location and Spacing: Hydrants should generally be provided at each street intersection and at intermediate points between intersections as required. Generally, hydrant spacing may range from 400 to 600 feet depending on the area being served.

1.08 SERVICE METERS

Each service connection, except fire service, shall be individually metered. Fire services shall be installed with a detector check meter system.

1.09 DEAD ENDS

Dead ends shall be minimized by looping of all water mains whenever practical. Hydrants shall be placed at the end of all dead end lines. Blow-offs shall not be substituted for hydrants.

1.10 SEPARATION OF WATER MAINS AND SANITARY SEWERS

A. Horizontal Separation

Water mains shall be laid at least 10 feet horizontally from existing or proposed sewer.

B. Vertical Separation

Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. At crossings, one full length of water pipe shall be located so both joints will be

as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

C. Force Mains

There shall be at least a 10 foot horizontal separation between water mains and sanitary sewer force mains. There will be an 18 inch vertical separation at crossings.

D. Sewer Manholes

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

E. Special Conditions

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, concrete encasement shall be required to be installed a minimum of 5 feet each side of the crossing point on the lowest utility.

END OF SECTION

SECTION 1B - DESIGN PARAMETERS FOR SANITARY SEWERS

1.11 GENERAL

A. Where existing sewer mains are to be extended for a residential or commercial development, the developer is responsible for connecting to existing sewers or manholes and extend as required. Developers shall hire a contractor approved by the Town of Bridgeville and pay all costs associated with the extension. The Developer shall install sewer laterals with cleanouts in the pipe laying process.

B. Laterals shall be constructed of the same material as the sewer main. Maintain a minimum of 24-inch cover. Lateral extensions from the cleanout to the house shall conform with County Plumbing Regulations.

1.12 PROJECT DRAWINGS

A. Title Sheet

1. Title of Project and Address.
2. Phase of Project if necessary.
3. Developers' Name and Address.
4. Design Engineers Name and Address.
5. Drawing Index.
6. Approval Block for Town Engineers' signature and date.
7. Vicinity Map showing location of Project within the Town. Typical scale shall be one inch equals 1000 feet.
8. Location Map if drawings are for one phase of the development.
9. Design Engineers' Seal and Signature.
10. Certification by the Design Engineer to the accuracy of the drawings.
11. Certification by the Developer approving the drawings.
12. Design calculations and daily flows with total number of units, lots, etc.

B. Horizontal Plan (Sanitary Sewers)

1. The scale shall be 1 inch equals 20 feet for small projects up to a maximum of 1 inch equals 40 feet for large projects. Profiles to be 1 vertical for each 10 horizontal scale.
2. North Arrow shall be shown.
3. The existing and proposed legend.
4. All necessity utility notes.
5. Location, elevation and description of all the Project Bench Marks.
6. Location, sizes, type and slope of all sanitary sewer lines with stations corresponding to the profiles.
7. Location of all manholes with grades between any elevation of flow line, and all invert elevations.
8. Property lines and Township, with details of easements where required.
9. Location of all proposed structures and buildings with unit numbers.
10. Beginning and end of proposed construction.
11. Location of proposed laterals, wyes, etc.
12. Location of all other drainage facilities and public utilities.
13. Proposed manhole numbers and cleanouts and proposed lot numbers.
14. All existing sanitary sewer facilities (i.e. manholes and pipelines) shall be

shown and labeled.

C. Profiles (Sanitary Sewers)

1. The horizontal scale shall be identical to the Horizontal Plan and vertically, 1 inch equals 2 feet for small projects up to 1 inch equals 5 feet for large projects.
2. Profile of existing and proposed ground surface.
3. Profile of sanitary sewer showing, type and size of pipe, slope, manholes and concrete encasement (if any). Designate manhole diameters if other than 48 inches.
4. Location of all other drainage facilities and public utilities crossing sanitary sewer lines.

D. Details (Sanitary Sewers)

Standard construction details as shown in the Standard Detail Section of this Booklet shall be included on the construction drawings where applicable. Details for construction other than the Standard Details shall also be shown on the project drawings.

1.13 DESIGN CAPACITY

In determining the required size and capacity of the sanitary sewer, the following factors should be considered:

A. Average and peak hourly domestic sewage flow.

B. Topography of area.

C. Depth of excavation.

D. Pumping requirements if necessary.

The calculations for design of the sanitary sewers shall accompany the Project's Drawings, when submitted for review.

1.14 DESIGN FLOW

A. Per Capita Flow

The sanitary sewer system shall be designed on the basis of an average daily flow of sewer of 225 gallons per day equivalent dwelling unit, unless otherwise required or approved by the Town Engineer.

B. Peak Design Flow

Sanitary sewers shall be designed on a peak flow basis using the 4.0 ratio of peak to average daily flow. For average flow above 1.0 m.g.d. the peak sewage flow is three times the average sewage flow.

1.15 MINIMUM SIZE

A. Sanitary Sewer Mains

The required size of sanitary sewer mains will vary with the character and size of the Development. The minimum size for sanitary sewer main is eight (8") inches.

B. Lateral Connections

Lateral cleanouts are required for use with all laterals unless a written waiver is received from the Town Engineer.

Each individual dwelling unit and multi-family units, with the exception of structures where each unit may not extend to the ground floor, shall have an individual lateral installed. The minimum diameter of laterals extending from the Town maintained cleanouts shall be six (6") inches. Laterals shall be placed at the property line. An additional lateral shall be placed five (5) feet from the foundation line for homeowner maintenance. Additional laterals shall be per the State Plumbing Code in effect.

1.16 DEPTH OF SEWER

Minimum depth of sewer mains shall be three (3') feet as measured from the top of the pipe to finished grade. Any piping not meeting the required minimum depth shall be concrete encased.

1.17 SLOPES

All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Mannings formula. If possible, pipe slopes should be increased above minimum slope in locations where pipes will carry functional flow.

Using an "n" value of 0.012 for P.V.C., the following are the minimum slopes which are allowed:

Sewer Size	Minimum Slope in Feet Per 100 Feet
8 inch	0.30
10 inch	0.22
12 inch	0.20

Using an "n" value of 0.013 for Ductile Iron Pipe, the following are the minimum slopes which are allowed:

Sewer Size	Minimum Slope in Feet Per 100 Feet
8 inch	0.40
10 inch	0.28
12 inch	0.22

1.18 MANHOLES

A. Location and Spacing

Manholes shall be installed at the end of each line; at all changes in grade, size or alignment; at all intersections, and at distances not greater than 400 feet.

B. Cleanouts

Terminal cleanouts shall not be substituted for manholes. However, terminal cleanouts may be approved under Special Conditions by the Town Engineer on a case by case basis. Under no conditions shall terminal cleanouts be installed at the end of a main line sewer greater than 150 feet from the last manhole.

C. Drops

A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the flow channel should be filtered to prevent solids deposition.

D. Minimum Diameter

The minimum diameter of manholes shall be 48 inches. Larger diameters are required for drop connections in new construction. A minimum access diameter of 24 inches shall be provided.

E. Flow Channels

The flow pipe channel through manholes should be made to conform in shape and slope to that of the sewers. The top of the brick channel shall be at the same elevation as the crown of the main sewer line in the manhole. Channel shall drop a minimum of 0.10 foot from influent pipe to the effluent pipe.

END OF SECTION

SECTION 1C - DESIGN PARAMETERS FOR SEWAGE PUMPING STATIONS AND FORCE MAINS

1.19 PROJECT DRAWINGS

A. Title Sheet

1. Title of Project and Address.
2. Phase of Project if necessary.
3. Developers' Name and Address.
4. Design Engineers Name and Address.
5. Drawing Index.
6. Approval Block for Town Engineers signature and date.
7. Vicinity Map showing location of Project within the Town of Bridgeville. Typical scale shall be one inch equals 1000 feet.
8. Location Map if drawings are for one phase of the development.
9. Design Engineers Seal and Signature.
10. Certification by the Design Engineer to the accuracy of the drawings.
11. Certification by the Developer approving the drawings.

B. Site Plan (Pumping Stations)

1. The scale shall be a maximum 1 inch equals 20 feet. Deviation from this scale shall be approved by the Town Engineer prior to preparation of the drawings.
2. North Arrow shall be shown.
3. The existing and proposed legend.
4. All necessity utility notes.
5. Location, elevation and description of all the Project Bench Marks. (Use U.S.G.S. mean sea level as Datum).
6. Location and sizes of all sanitary sewer lines and force mains with stations corresponding to the profiles.
7. Location and numbers of all manholes with elevations of inverts and the top of each manhole.
8. Metes and bounds for property lines which Township is to be deeded to the Town with details of any easements where required.
9. Location of all proposed structures, buildings, electrical service with transformers, equipment cabinet, generator, etc.
10. Beginning and end of proposed construction.
11. Location of all other drainage facilities and public utilities.
12. Existing and proposed contours and any related landscaping.
13. All existing sanitary sewer facilities (i.e., manholes and pipelines) shall be shown.
14. Pump and system curves showing the system's flow and total dynamic head for both proposed and future demands.
15. The transfer of ownership for the lands where the pump station is constructed shall be made to the Town prior to the Beneficial Occupancy acceptance by the Town of the project where such station is to be owned and operated by the Town. The developer shall furnish a 1 year warranty and pay all maintenance fees for the station for the warranty period as assessed by the Town or required for repair and maintenance. Maintenance fees paid by the Developer shall exclude electricity. The

Developer shall post a bond or letter of credit with the Town in the amount of 100% of the station construction cost as security for Town incurred costs during the warranty period.

C. Horizontal Plan (Force Main)

1. The scale shall be a maximum of 1 inch equals 40 feet. Deviation from this scale shall be approved by the Town Engineer prior to preparation of the drawings.
2. North Arrow shall be shown.
3. The existing and proposed legend.
4. All necessity utility notes.
5. Location, elevation and description of all the Project Bench Marks. (Use U.S.G.S. mean sea level as Datum).
6. Location and sizes of all sanitary sewer lines and force mains with stations corresponding to the profiles.
7. Location and numbers of all manholes with elevations of inverts and the top of each manhole.
8. Property lines and Township, with details of easement where required.
9. Location of all proposed structures and buildings, for example, the equipment cabinet, transformers, generator, etc.
10. Beginning and end of proposed construction.
11. Location of all other drainage facilities and public utilities.
12. Existing and proposed contours and any related landscaping.
13. All existing sanitary sewer facilities (i.e., manholes and pipelines) shall be shown.
14. Location of proposed force main discharge manholes and air release valves where applicable.
15. Location of bends, buttresses and encasements.

D. Profiles (Force Mains)

1. The horizontal scale shall be identical to the force main plan. Vertical scales shall be 1/10 of the horizontal scale and shall equal 5 feet of large projects.
2. Profiles of existing and proposed ground surface over the centerline of the pipe with elevations at the top of manholes and air release vaults and at the flow line.
3. Profiles of force main showing pipe size, slope, manholes, air release vaults, bends and any necessary concrete encasements.
4. Minimum force main cover shall be 4’-0”measured from the top of pipe to proposed grade.
5. Location of all other drainage facilities and public utilities crossing the force main.

E. Details (Pump Stations and Force Mains)

1. Standard Construction Details are shown in the Standard Details Section of this Booklet. They shall be included on the drawings where applicable.

1.20 DESIGN CAPACITY

In determining the required size and capacity of the pumping station and force mains, the following factors should be considered:

A. Maximum hourly domestic sewage flow. Average daily flow times a peak factor of 4.0.

B. Topography of area.

C. At no place on the pump curve shall the horsepower rating of the pump motor be exceeded.

D. The volume of the wet well between the start elevation and the stop elevation of a single pump.

E. The calculations for design of the pump station shall accompany the Project's Drawings, when submitted to the Town Engineer for review.

1.21 PUMP STATIONS

A. General

1. Flooding - Sewage pump station structures and electrical and mechanical equipment shall be protected from flooding and physical damage by the one hundred (100) year flood. Sewage pump stations should remain fully operational and accessible during the twenty-five (25) year flood.

2. Accessibility - The pump station shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

3. Station Type - Station type shall be coordinated with the public works director based on flow, location and standardization desired.

4. Electrical plans are required with detailed specifications for control. Provide NEMA-rated equipment, Square D or equal. Include rate of flow, totalizer, elapsed time meters, automatic alternation, run lights and alarms as a minimum. Permanently mounted Generators are required for flows of 200 gpm or greater. Portable generators are required for all smaller pump stations. Positive ventilation shall be provided. Coordinate telemetry equipment requirements with Department of Public Works.

5. Contractor shall provide independent inspection agency certification that electrical system meets applicable codes.

B. Pumps and Hardware

1. Multiple Units - Two (2) pumps at a minimum shall be provided. Approved submersible pumps including Flygt and ABS.

2. Hardware shall be stainless steel including guide rails, brackets, chains,

cables, etc.

3. Each pump shall have the same capacity and individually shall be capable of handling flows in excess of the expected maximum flow.

4. Station may be required to have hoist, trash basket, comminutor, odor control depending on location, size, and service.

C. Valves

1. Discharge Line - Suitable shutoff and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the shutoff valve and the pump. Valves shall be capable of withstanding normal pressure and water hammer. Gate valves shall have rising sterns and be of the resilient seat type.

2. Vault - The pump station shall include a concrete valve vault to house the valves.

3. By-Pass Handhole - Install an emergency forcemain connection near the wet well using an isolation valve and valve box and a stainless steel quick connection in a lamphole with 24" minimum access. Frame and cover shall be cast iron.

D. Wet Well

1. Size - The wet well size and control setting shall be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time. Pump shall be completely submerged at pump off level, or be explosion proof. Pumping volume between "Pump On" and "Pump Off" shall be:

$$V = \frac{7 \times gpm}{4}$$

2. Floor Slope - The wet well floor shall have a minimum slope of one to one to form the hopper bottom. The horizontal area of the hopper bottom shall not be greater than necessary for proper installation and function of the pump inlet.

3. Material - Wet well shall be reinforced concrete.

1.22 GREASE TRAPS

A. Grease traps are required for all commercial operations, restaurants, convenience stores, etc. which have cooking operations. Traps shall be designed to prevent accumulation of grease in sanitary sewers. Maintenance of grease traps shall be at a minimum of one (1) time every three (3) months or as needed. Maintenance is the responsibility of the property owner. The property owner shall submit to the Town a maintenance contract with a local hauler defining these responsibilities for inspection and pump out as required. Maintenance records shall be made available to the Town upon request.

B. Capacity of grease traps shall be determined based on the specific application. Minimum size shall be 1,000 gallons.

The following formula shall apply:

1. <u>Restaurants:</u>

(D) × (GL) × (ST) × HR/2 × (LF) = Size of Grease Interceptor, gallons*

where:

D	=	Number of seats in dining area
GL	=	Gallons of wastewater per meal, normally 5 gal
ST	=	Storage capacity factor -- minimum of 1.2
HR	=	Number of hours open
LF	=	Loading factor –
		1.0 major highway
		1.0 recreational areas
		0.8 main highways
		0.5 Town center

2. <u>Nursing Homes, Other Type Commercial Kitchens:</u>

(M) x (GL) x (ST) x (2.5) x (LF) = Size of Grease Interceptor, gallons*

where:

M	=	Meals per day
GL	=	Gallons of wastewater per meal, normally 2.0
ST	=	Storage capacity factor -- minimum of 1.7
LF	=	Loading factor --
		1.25 garbage disposal & dishwashing
		1.00 without garbage disposal
		0.75 without dishwashing
		0.50 without dishwashing and garbage disposal

*Minimum size grease interceptor should be 250 gal.

Thus, for a restaurant with a 75-seat dining area, an 8 hour per day operation, a typical discharge of 5 gal. per meal, a storage capacity factor of 1.7 and a loading factor of 0.8, the size of the grease interceptor is calculated as follows:

(75) x (5) x (1.2) x 8/2 x (0.8) = 1,440 gal.

Other design considerations include: facilities for insuring that both the inlet and outlet are properly baffled; easy manhole access for cleaning; and inaccessibility of the trap to insects and vermin.

1.23 FORCEMAINS

A. Forcemains shall be sized for a flow velocity of 2.0 feet per second minimum and 6.0 maximum.

B. Designer shall use Hazen & Williams equation and shall plot system curves for new pipe (C=140 for PE or PVC or C= 130 for DIP) and minimum static head condition, and secondly for old pipe (C = 120 for PE or PVC or C = 100 for DIP) and maximum static head condition.

C. Materials must be approved by the Town.

D. Design and construct forcemain in profile with grades controlled to plus or minus one-half inch to prevent unnecessary high points. Install an air release valve at each high point and at intervals as needed along flat or nearly flat forcemain grades. Air valves shall be cast iron combination sewage type with stainless steel internals, stainless steel isolation ball valve with street ell attached to the top of the outlet to prevent contamination from debris, and provided with flushing connections. Depth of forcemain at high points at air release valves shall be sufficient to accommodate equipment with top of manhole flush with grade in pavements, shoulders, or traffic ways.

1.24 OIL/WATER SEPERATOR AND RECYCLED WASH WATER

A. All new and/or upgraded vehicle washes and vehicle maintenance garages shall install (Model HT) Highland oil/water separators of adequate size for proper operation. New and/or upgraded vehicle washes shall install a recycled water system to minimize sewer flows.

END OF SECTION

SECTION 1D - DESIGN PARAMETERS FOR STREETS

1.23 GENERAL

A. Where a Developer proposes to construct public streets in the Town of Bridgeville, such streets shall be designed to the Standards defined herein. Streets shall be designed and constructed to Town Standards and conveyed to the Town upon acceptance.

B. Sussex Conservation District as applicable shall issue permits required for erosion control and stormwater management. Their requirements are in addition to those defined herein.

1.24 LAYOUT, RIGHT-OF-WAY AND STREET DESIGN

A. The arrangements of streets shall be such as to provide for the appropriate extension of existing streets.

B. Minor streets shall be so designed as to discourage through traffic.

C. Subdivisions abutting arterial streets shall provide a marginal service road, or reserve frontage with a buffer strip for planting, or some other means of separation of through and local traffic as the Planning Commission may determine appropriate.

D. The minimum right-of-way width shall be measured from lot line to lot line and shall be in accordance with the following schedule:

1. Arterial Streets - 80'-120'
2. Collector Streets - 50'
3. Minor Streets - 50'
4. Marginal Access Streets 40'
5. Alleys – 20’
6. Driveways, aisles and parking areas in business and industrial developments shall be designed and built to satisfy the requirements of the Town of Bridgeville.

E. Grades of arterial and collector streets shall not exceed four (4%) percent. Grades on other streets shall not exceed ten (10%) percent. No street shall have a minimum grade of less than five tenths (0.5%) of one percent.

F. Street intersections shall be as nearly at right angles as is possible and in no case shall be less than sixty (60) degrees. The block corners at intersection shall be rounded at the curb line with a curve having a radius of not less than twenty (20') feet.

G. Street jogs with center line offsets of less than one hundred twenty-five (125') feet shall be prohibited.

H. A tangent, at least one hundred (100') feet along, shall be introduced between reverse curves on arterial and collector streets.

I. When connecting street lines deflect from each other at any point by more than ten (10) degrees they shall be connected by a curve with a radius of not less than one hundred (130') feet for Minor Streets and three hundred (300') feet for Arterial and Collector Streets.

J. All changes in grade greater than 1% shall be connected by vertical curves of sufficient radius to provide a smooth transition and proper sight distance.

K. Dead-end streets (cul-de-sac) of a permanent nature shall not be longer than four hundred (400') feet and shall provide a turn around at the end with a radius of forty (40') feet of pavement and a 50' radius right-of-way.

L. If a dead-end street is of a temporary nature, a similar turn around shall be provided and provisions made for future extension of the street and reversion of the excess right-of-way, to the adjoining properties.

M. No street shall have a name which will duplicate or so nearly duplicate as to be confused with the names of existing streets. The continuation of an existing street shall have the same name.

N. Right-of-way concrete monuments shall be set at each change of direction, along both sides of the approved right-of-way.

O. Roundabout designs are subject to Town Engineer's approval.

1.25 PROJECT DRAWINGS

A. Title Sheet

1. Title of Project and Address.
2. Phase of Project, if necessary.
3. Developers' Name and Address.
4. Design Engineers Name and Address.
5. Drawing Index.
6. Approval Block for Town Engineers signature and date.
7. Vicinity Map showing location of Project within the Town of Bridgeville. Typical scale shall be one inch equals 1000 feet.
8. Location Map if drawings are for one phase of the development.
9. Design Engineers Seal and Signature.
10. Certification by the Design Engineer to the accuracy of the drawings.
11. Certification by the Developer approving the drawings.

B. Horizontal Plan

1. The scale shall be 1 inch equals 20 feet for small projects up to a maximum of 1 inch equals 40 feet for large projects.
2. North Arrow shall be shown.
3. The existing and proposed legend.
4. All necessity utility notes.
5. Location, elevation and description of all Project Bench Marks.
6. Property lines, lot lines, lot numbers and easements.
7. Location of all proposed structures and buildings with unit numbers.

8. Beginning and end of proposed construction, including phase limits.
9. Existing and proposed street names.
10. Drainage pipe, culverts, swales with inverts, slopes and spot elevation and pipe material.
11. Location of all other drainage facilities and public utilities.
12. Existing and proposed contours (1 foot vertical intervals) with major vegetation noted.
13. Stationing of roads with curve data, points of tangent and curve.
14. Curbing locations with type denoted plus top and bottom elevations and minimum 100 foot intervals, at all points of tangency, at all changes in grade and at intersections.

C. Profile

1. Scale shall match plan horizontally. Vertical scale shall be 1 inch equals 2 feet for small projects up to a maximum of 1 inch equals 5 feet for larger projects.
2. Drainage pipe and swale data.
3. Vertical curve information.
4. Street Name.
5. Stationing.

D. Details

1. Street cross section.
2. Curbing type.
3. Entrance plan.
4. Storm drainage details.
5. Storm drain profiles to comply with sanitary sewer plan requirements.

1.26 SIGNAGE AND PAVEMENT MARKINGS

A. All streets shall be designed with adequate traffic control signage and pavement markings meeting the Manual of Uniform Traffic Control Devices standards. Pavement markings shall use Thermostripe materials.

B. Street parking and travel lanes shall be delineated by striping when directed.

END OF SECTION

SECTION 1E - SOILS INVESTIGATION AND PAVEMENT DESIGN

1.27 SOILS INVESTIGATION

A. The Developer of a proposed subdivision where roads will be conveyed to the Town of Bridgeville shall employ the services of an Engineer to perform a subsurface investigation for the purpose of obtaining information needed to design the proper pavement section.

B. The design Engineer shall employ a Geotechnical Engineer registered in the State of Delaware as applicable who is qualified and experienced in the field of Geotechnical Engineering and who is actually engaged in the practice of soils mechanics and foundation engineering.

C. Borings shall be made for all proposed streets within the project area. The following guidelines and methods will be followed when performing the field work:

1. Borings shall be accomplished by using hollow stem augers and/or other equipment necessary to obtain soil samples of each stratum encountered.
2. Boring locations shall be placed along the centerline of the street no more than 300 feet apart, with a minimum of two (2) borings per street.
3. Borings shall be performed to a depth of 6 feet below the subgrade of the proposed pavement system.
4. Soil shall be sampled by stratum. At each soil composition change, a sample, sufficient in size to perform the required laboratory testing, shall be obtained.
5. When water is encountered, borings should be left open until water level stabilizes and then depth to water should be recorded.
6. A log of each boring should be performed by the Geotechnical field personnel. The following information should be recorded on the boring log.

    a. Name of street.
    b. Location of boring -- station and offset.
    c. Surface elevation.
    d. Date boring was performed.
    e. Depth, vertical arrangement and thickness of each stratum.
    f. Sample number.
    g. Visual soil classification of each stratum.
    h. Depth to water (if encountered).

D. The following laboratory tests shall be performed on the material sampled from each stratum encountered in the individual borings:

1. Practice for dry preparation of soil samples for particle-size analysis and determination of soil constants (ASTM Designation D-421).
2. Method of particle-size analysis of soils (ASTM Designation D-422).
3. Amount of material in soils finer than the number 200 sieve (ASTM Designation D-1140).
4. Method of laboratory determination of water content of soils (ASTM Designation D-2216).

5. Classification of soils for engineering purposes (ASTM Designation D-2487).
6. Test method for liquid limit, plastic limit and plasticity index of soils (ASTM Designation D-4318) when required.

E. Methods which deviate from any of the above procedures must be submitted to the Town of Bridgeville for approval.

F. Results of the soil investigation submitted to the Town of Bridgeville should contain the following information:

1. A plan view of the proposed streets showing boring locations.
2. Logs containing the required data for all borings made.
3. Tests results of all laboratory tests performed.
4. A profile view of each street with borings plotted to scale showing the ASTM classification of soils encountered.
5. Pavement design report by geotechnical engineer.

1.28 SUBDIVISION PAVEMENT DESIGN

A. Subdivision streets shall be designed based on the following standards and practices. Streets serving more than 300 homes or industrial uses may be subject to additional requirements.

B. The applicable details show typical sections for residential streets, based on the following definitions:

1. Minor Street - A street which will serve less than 50 dwelling units.
2. Minor Collector Streets - A street serving between 50 and 300 dwelling units.

C. The design of pavement sections for streets shall be based on the type of soils as determined by the soils investigation, the anticipated number of units utilizing the streets and utilization of streets by construction traffic.

D. The required structural numbers are shown in the attached tabulations.

E. A minimum of 3-1/2 inches of bituminous base course and 1-1/2 inches of surface course and 6 inches of compacted graded aggregate subbase course shall be used.

F. Prior to placing the pavement and graded aggregate section, the subgrade shall be prepared and test rolled in the presence of the Town Engineer. If the test rolling shows the subgrade to be unstable, the Contractor shall scarify, disc, aerate or add moisture and recompact the subgrade to the extent that when retested it will be stable. If, in the opinion of the Engineer, there are areas to be removed or undercut, they may be ordered to excavate and replace with approved material.

G. The total minimum required structural number, based on the number of units using the street, are as follows:

Required Structural Number

No. of Units	Good Soil	Poor Soil
1 -50	1.70	2.70
51 - 100	2.00	2.90
101 - 200	2.50	3.30
201 - 300	2.90	3.70
Over 300	N/A	N/A

NOTE: Good soils consist of soils within the A-1, A-2 and A-3 AASHTO soil classifications.

Poor soils consist of all other soil classifications.

H. The pavement section of street built to serve a future area of development shall be increased in strength to serve both the present and future traffic loads. If such a street must also serve construction traffic of future development, the pavement section shall again be increased in strength as follows:

No. of Units Proposed for Future Development Area	Increase in Structural Number
1 - 100	0.48
101 - 300	0.80

I. Following is the list of structural numbers used to obtain a pavement section thickness which will meet or exceed the minimum required structural number shown above:

Use	Material for Inch Thickness	Structural Number
Surface Course	Bituminous Concrete	0.40
Base Course	Bituminous Concrete	0.40
Subbase Course	Graded Aggregate	0.14
	Select Borrow	0.08

J. In cases where the bituminous asphalt base course will be used for construction traffic, or where there is a delay in the installation of the bituminous top course, the thickness of the bituminous base course shall provide initial paving section with a structural number (SN) which meets or exceeds the SN of the finished

roadway design. Streets under construction shall be maintained free of standing water and any damaged or soft pavement and subgrade shall be removed and replaced prior to installation of the final bituminous surface course.

K. The above design procedure is not applicable for streets serving over 300 units.

END OF SECTION

SECTION 1F – STORM DRAIN SYSTEMS

1.29 STORM DRAIN SYSTEMS

A. Design of storm drain systems shall be in accordance with drainage criteria of the State of Delaware, Division of Highways, Rules and Regulations for Subdivision Streets.

B. Double inlets shall be installed in all low points, unless otherwise approved for small contributing areas.

C. Design engineer shall certify the design and submit storm drainage report and calculations.

D. Storm drain system shall be designed for a hydraulic grade line maintained below the inlet elevation of the catch basin during a 10-year storm. Catch basins shall be designed to maintain less than 8' gutter spread during a 10-year storm.

E. The minimum pipe size for culverts and storm drainage is 15" with a maximum of 300' between inlets or manholes.

F. New or different stormwater management technology acceptable to the Sussex County Conservation District may be considered by the Town of Bridgeville on a case-by-case basis. However, the Town may not approve this technology if it is not in the best interest of the Town.

END OF SECTION

SECTION 1G – PROJECT DRAWINGS

1.30 FINAL SITE AND SUBDIVISION CONSTRUCTION IMPROVEMENT PLANS

The Developer and his Engineer are responsible for preparation of detailed drawings. Sheet numbers shall be placed in a prominent location in the lower right corner of each sheet and shall use the following order and sheet number conventions. The requirements of this Section are in additional to project drawings requirements in other sections.

A. Revision Blocks

Provide a revision block on each sheet to accurately disclose and identify all drawing revisions made after the first submittal for preliminary plan review.

B. Title Sheet and General Sheet

1. Title of Project and Address.
2. Phase of Project if applicable
3. Developers' Name, address, phone, signature.
4. Design Engineers' Name, address, phone and fax number.
5. Property Owner's name, address, and signature
6. Drawing Index
7. Certification Blocks
8. Location Map showing location of Project within the Town and related to area streets. Scale shall be no smaller than one inch equals 1000 feet.
9. Phasing Map if drawings are for one phase of the development.
10. Design Engineer's Seal and Signature.
11. General Legend
12. General Notes:

The following minimum general notes shall appear on construction improvement plans:

1. Construction shall meet the requirements of the Town of Bridgeville Construction Standards and Specifications for Water, Sewer, and Streets latest edition and all applicable agencies having jurisdiction over this work.
2. All sanitary sewer mains and force mains shall have a minimum cover of 36 inches and all water mains shall have a minimum cover of 42 inches as measured from top of pipe to proposed grade. Sewer laterals shall be ~~a~~ 6 inches in diameter and have a minimum cover of 3 feet.
3. There shall be a minimum horizontal separation between water mains and sanitary sewer mains or force mains of 10 feet, as measured edge to edge. There shall be a minimum vertical separation of 18 inches between water mains and sanitary sewer mains or force mains at crossings. One full length of water pipe shall be located so both joints will be as far from the sewer as possible at crossings.
4. There shall be a minimum vertical separation of 12 inches between any storm drain pipe and any water main or sewer main. If twelve 12 inches cannot be maintained, a minimum of 6 inches is required and provisions

shall be made acceptable to the Town of Bridgeville for properly ~~encasing~~ cradling the upper pipe with concrete.

5. Topography was performed by (fill in blank) on (fill in blank) (dates). Elevations are based on Control Monument (fill in blank) with an elevation of (fill in blank) NAVD88.
6. Horizontal Datum is based on Delaware State Grid NAD 83/91 Control Monuments (fill in blank).
7. Hydric soils (are) or (are not) indicated on this site by the Sussex County Soil Survey. Hydric soils have been inspected by (fill in blank) a Professional Licensed Wetlands Scientist
8. Soils investigation and pavement design for subdivision streets to be dedicated to the Town of Bridgeville were performed by (fill in blank), a geotechnical engineer licensed in Delaware.
9. The storm drainage system to be dedicated to the Town of Bridgeville has been designed using the criteria of the State of Delaware Division of Highways Rules and Regulations for Subdivisions Streets latest revision.
10. Number of dwelling units; (referenced to each type of housing)
11. Number of commercial and institutional units and proposed square footage for each usage.

C. DETAILS

1. Provide copies of applicable utility, street and storm drain details per Standard Construction Details as provided by the Town of Bridgeville for all facilities proposed to be dedicated to the Town.
2. Dimension all air release valve vault or manhole details for each location installed.
3. Street cross section
4. Curbing type(s), and sidewalks.
5. Entrances
6. Other as required

D. CERTIFICATIONS AND SIGNATURE BLOCKS FOR FINAL IMPROVEMENT PLANS (This information is to be located on the Title Sheet).

1. ENGINEER (SURVEYOR, ARCHITECT) STATEMENT (as applicable): (Note to applicant: Site plans which contain public street, public utilities, or stormwater management shall be sealed by an Engineer or a Surveyor. Pump stations must be sealed by an Engineer.)

   It is hereby certify that I am a registered engineer (licensed surveyor, registered architect) in the State of Delaware, that the information shown hereon has been prepared under my supervision and to my best knowledge and belief represents good engineering practices as required by the applicable laws of the State of Delaware. (Print Name, Address and Phone Number)

   Signature:_____Date:_____

2. OWNER'S AND DEVELOPER'S CERTIFICATION

It is hereby certified that I am the developer of the property described and shown on this plan. The plan was made at my direction, that I acknowledge the same to be my act. It is my desire to have the plan developed as shown and in accordance with all applicable laws and regulations.

Signature: Owner_____Date:_____
(Print Name, Address and Phone Number)

Signature: Developer_____Date:_____
(Print Name, Address and Phone Number)

3. TOWN ENGINEER

Construction improvements plans have been reviewed and are found to be in general conformance with the Town of Bridgeville Construction Standards and Specifications for Water, Sewer, and Streets. The owner and his engineer and/or surveyor assume all responsibility for design and accuracy of information shown hereon.

Signature:_____ Date:_____

4. TOWN OF BRIDGEVILLE APPROVED BY:

Town Manager: _____ Date: _____

1.31 RECORD DRAWINGS

A. Contractor shall perform an as-built survey of all sewer pipe and storm drain pipe elevations and submit to the Town within 30 days of pipe installation. Survey shall be by a licensed Delaware surveyor. No later than 30 days after completion of construction, submit six (6) copies of record drawings with as-built information including surveyed as-built elevations of all manholes, pump stations, and force mains at air release valves. Also submit one copy of record drawings on AutoCAD or other digital disk format approved by the Town. Digital drawings shall be on Delaware State Plane Horizontal control and NAVD 88 Vertical control.

END OF SECTION

SECTION 2

CONSTRUCTION SPECIFICATIONS

SECTION 2A - EXCAVATION AND BACKFILL FOR PIPELINES AND STRUCTURES

1.01 GENERAL

A. The Contractor shall perform all excavation, backfilling, grubbing and grading required for construction and installation of pipelines, structures and appurtenances. Excavation shall include removal of pavement, concrete, rock, earth and debris, regardless of character. Trenches and excavations shall be sheeted, shored and braced by the Contractor, as necessary to allow construction and provide safe working conditions. Additionally, the Contractor shall be responsible for maintaining a dry excavation by dewatering. He shall also support and protect existing utilities and structures encountered in the work, provide traffic control, dispose of surplus and unsuitable excavated materials and restore backfilled areas to original condition or as required by the respective contract drawings and specifications.

B. The Contractor is responsible for direct or indirect damage to existing structures, pipelines, conduits, poles, wires of every description in the vicinity of his work whether above or below ground, or that may be encountered in trench or structure excavation. This responsibility shall include the cost of protection by sheeting, bracing, hand excavation, when warranted, and the expense to repair or replace any existing facility damaged directly or indirectly by construction activities, whether such facility is or is not shown on the drawings.

C. The Contractor shall verify the location and inverts of all existing utilities at the various points of connection and/or crossings prior to starting any work. Any discrepancies in locations or inverts shall be brought to the attention of the Engineer or the Town in order that the designs may be adjusted accordingly. Damages suffered or additional costs incurred by the Contractor as a result of his failure to conform to the requirements of this paragraph shall be the sole responsibility of the Contractor. Connections to existing utilities shall be made by the Contractor at such a time and in such a manner as the Engineer or Town may direct.

D. Excavation and backfill, within an area where a State agency has jurisdiction, shall be done in accordance with requirements and provisions of the permits issued by the agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these specifications.

E. Prior to excavation, soil explorations in the area of the proposed project will be carried out by a qualified geotechnical engineer to determine subsurface conditions.

1.02 PIPELINE TRENCH EXCAVATION

A. The Contractor shall excavate, maintain and backfill all excavation necessary for completing the work under the contract. Unless otherwise specified or approved, excavation shall be open cut.

B. Trenches shall be excavated to the necessary width and depth, as shown on the drawings and as required for the safe installation of the utility, etc.

C. The sides of the trenches shall be practically plumb and shall not be sloped unless approved in writing by the Engineer. Trench sides shall be supported or sheeted, as required, to protect pavement surfaces, curbing, utilities, etc., and required for safety. Safety regulations shall be as required by State safety codes and OSHA.

D. In paved areas, the Contractor shall remove the paving only as necessary for the excavation of the trench or as detailed. Pavement edges at the trench shall be saw cut neat and straight prior to the start of any excavation. Should the pavement damage result from cave-ins, settlement, etc., he shall replace such paving at his own expense.

E. The excavation of all trenches shall be fully completed at least twenty (20) feet in advance of pipe laying, unless otherwise authorized or directed. The Engineer or Town may require the backfilling of open trench, over completed pipelines, or ahead of the pipe laying operation, if in his judgement such action is necessary.

F. Should work be stopped for any reason and any excavation is left open for an unreasonable length of time, the Contractor shall refill the excavation at his own expense if so directed and shall not reopen the excavation until he is ready to complete the facility. Should the Contractor refuse or fail to refill any excavation completely within eight (8) hours after a proper notice, the Town shall be authorized to do the work and expenses resulting shall be paid by the Contractor.

G. The Contractor shall complete excavation as nearly as practicable to the lines of the utility to be installed as detailed. All cavities in the bottom of the trench shall be filled to the required level with compacted crushed stone or gravel.

H. Excavated materials shall be graded, hauled, stored and protected as such material found suitable will be required for backfilling, repaving or other purposes. Material classified as unsuitable shall be disposed of by the Contractor.

I. Excavated materials shall not be placed on private property, unless written permission is obtained from the property owner.

J. The Contractor shall be responsible for any damage to curb, gutter, sidewalk, traffic control devices and pavement material. Any damage resulting directly or indirectly shall be replaced in kind by the Contractor. The reuse of disturbed curb, gutter or sidewalk is prohibited. New sections shall be installed to the nearest undisturbed control joint.

1.03 PIPELINE TRENCH BACKFILL

A. Materials excavated from the trench shall be used for trench backfill, provided that, in the opinion of the Engineer or Town, the excavated material is suitable for this purpose. Backfill material shall be free from large lumps and stones having any dimension greater than two (2) inches.

B. Suitable material, as approved by the Engineer, shall be carefully deposited in the trench by methods which will not damage or disturb the pipeline or structure, and shall be solidly tamped around the pipe or structure. Backfill material shall

be placed in 8-inch layers. Care shall be taken in the use of mechanical tampers not to injure or move the pipe or to cause the pipe to be supported unevenly.

C. All backfill material shall be compacted to 95% of maximum density at + or - 2% of optimum moisture content as determined by the Modified Proctor Test, AASHTO T-180. Materials containing an excess of moisture shall be permitted to dry until the moisture content is within the specified range. Materials too dry shall be wetted uniformly until the moisture content is in the specified range.

D. No compacting shall be done when the material is too wet to be compacted properly. At such times the work shall be suspended until the backfill materials have dried out sufficiently to permit proper compaction or such other precautions shall be taken as may be necessary to obtain proper compaction. The Contractor is responsible for hauling, storing and drying of excavated material to be used in backfill operations.

E. The Engineer may request compaction tests of the backfilled trenches at any time during construction or upon completion of the backfill operations. Such testing shall be arranged by the Contractor and performed by an independent testing agency approved by the Engineer. The Contractor shall pay the testing laboratory for all tests performed inclusive of sample collection, preparation and transportation. If the results of any tests shown that backfills do not meet the specified compaction, the Contractor shall, at his own expense, correct the condition as directed by the Engineer.

F. The Contractor shall, at his own expense, maintain all refilled excavations in proper condition. Trench surfaces shall be reshaped when necessary. If the Contractor fails to make repairs within forty eight (48) hours after receipt of written notice from the Town, the Town may refill said depression wherever necessary and the cost of so doing will be paid by the Contractor. The Contractor shall be responsible for any injury or damage that may result from lack of maintenance of any refilled excavation at any time prior to final acceptance.

G. All unauthorized excavations made by the Contractor shall be immediately backfilled in accordance with the requirements of the specifications for trench backfill at the Contractor's expense.

H. After completion of backfilling, all material not used shall be disposed of and all places on the line of the work shall be left clean and in good condition. This cleaning up shall be done by the Contractor. If he fails to do this work within a reasonable time after receipt of notice, it will be performed by the Town and the cost will be assessed to the Contractor.

I. No backfill shall be placed against new concrete or masonry structures until properly cured. In the case of concrete, test reports must indicate that a 2500 psi compressive strength exists.

J. The Contractor shall exercise caution in backfill and compaction to prevent damage to structures.

1.04 EXCAVATION BELOW SUBGRADE AND GRAVEL REFILL

Materials below the excavation limit for pipelines and structures (below subgrade), which in the judgement of the Engineer or Town should be removed, shall be removed as directed. All spaces created by the removal of unsuitable material below subgrade shall be refilled and compacted with crushed stone or gravel.

1.05 DEWATERING

A. All excavations must be kept free of water below the subgrade of the work while work is in progress. This may be accomplished by ordinary pumping methods or by well points, whichever will produce the required results. Upon removal of dewatering equipment, the Contractor shall backfill all holes and restore disturbed areas to their original condition.

B. Dewatering for the structures and pipelines shall commence when groundwater is first encountered and shall be continued until such time as backfill has been completed. No concrete footings shall be laid in water nor shall water be allowed to rise over them until the concrete or mortar has set at least eight (8) hours. Groundwater shall not be allowed to rise around the pipe until the trench is backfilled.

C. The Contractor shall dispose of the water from the work in a suitable manner without damage to adjacent property. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be disposed of in such a manner as not to be a menace to the Public Health.

D. The Contractor shall remove any siltation deposits in storm sewer systems, resulting from his dewatering or construction operations. He shall also be responsible for conveyance of dewatering flows and for erosion and sediment control.

1.06 SHEETING, SHORING AND BRACING

A. The Contractor shall furnish and install all sheeting, shoring and bracing necessary to insure safe working conditions and to prevent damage to public and private property and structures. If, in the opinion of the Engineer, the sheeting, shoring, or bracing is not of proper quality or is not properly placed to insure safe working conditions and to prevent property damage, the Contractor shall remedy such inadequacy at his own expense, as may be directed by the Engineer. Sheeting, shoring and bracing shall be removed as backfilling progresses, except at such locations as the Engineer may direct or approve it to be left in place.

B. The Contractor shall cut off any sheeting left in place, at least eighteen (18") inches below finished grade, and shall remove the material cut off without compensation.

C. Where necessary, for the protection of any structure or property, sheeting shall be driven to such depth below the bottom of the trench as may be required, to protect all existing and/or proposed work.

D. A trench box is an acceptable alternative to sheeting, shoring or bracing provided

such boxes conform to safety codes in effect for the project.

1.07 SELECT BACKFILL

A. Should the Contractor encounter unsuitable material during excavation, he shall remove and dispose of such material.

B. Should sufficient suitable material from excavations on the project not be available for backfill, the Contractor shall furnish Select Backfill upon approval of the Engineer. Special backfill shall conform to Delaware Department of Transportation Type "C" Borrow.

C. The Contractor shall furnish certification that his borrow is from a Delaware DOT approved source.

1.08 TEMPORARY REPAVING

A. The Contractor shall furnish, place and compact two (2") inches of cold patch as temporary pavement surface over all backfill areas created for pipeline and structure installation located in roadways or driveways. This surface shall be maintained by the Contractor until permanent surface restoration has been performed.

B. Should the Contractor remove existing pavement beyond the width specified or detailed on the plans, or should pavement be disturbed from settlement, slides or other construction activities, he shall saw cut back the pavement and provide temporary paving in these areas.

C. On State highways and all other areas over which the Delaware Department of Transportation exercises jurisdiction, all pavement restoration shall be done in accordance with the permit requirements of the agency.

END OF SECTION

SECTION 2B - WATER MAINS AND APPURTENANCES

1.01 GENERAL

The Contractor shall furnish and install all water mains, valves, hydrants, fittings, corporation stops, house service piping and appurtenances as specified herein and as defined on the drawings or as directed by the Engineer. Provide all necessary adaptors for connection to existing mains. The Contractor is given the option of using ductile iron or PVC pipe. PVC pipe shall not be permitted for hydrant leads or inside of railroad or highway steel crossing sleeves.

1.02 DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C-151/ A21.51, latest edition, and shall be thickness Class 53 in streets and inside highway sleeves and Class 56 under railroads unless otherwise noted. The Contractor shall have the option of furnishing mechanical or push-on joints conforming to latest edition of ANSI/AWWA C-111/A21.11.

B. Pipe and fittings shall have an external standard asphaltic coating approximately 1 mil thick.

C. Pipe and fittings shall have an internal cement lining in accordance with latest revision of ANSI/AWWA C-104/A21.4. No bituminous coating shall be used on the inside of pipe and fittings unless prior written approval is obtained from the Delaware Division of Public Health.

D. All fittings and specials shall be cast iron or ductile iron with mechanical joint having a 250 psi pressure rating respectively, 350 psi in the case of the ductile iron. They shall be marked and manufactured in conformance with ANSI/AWWA C-110/A21.10, latest edition. Compact ductile iron fittings will be an acceptable alternate. They shall be mechanical joint with a 350 psi pressure rating conforming to ANSI/AWWA C-153/A21.53 and C-111/A21.11.

E. Mechanical joint restraints for ductile iron pipe shall be Megalug Series 1100, as manufactured by EBAA Iron, Inc. or approved equal. The joint restraints shall meet the applicable requirements of ANSI/AWWA C110/A21.10. They shall have a working pressure rating of 350 psi for 3 through 16-inch and 250 psi for 18 through 48-inch diameter piping.

1.03 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE AND FITTINGS

A. Polyvinyl chloride pipe shall meet the requirements of AWWA C-900. It shall be manufactured in standard length not exceeding 20 feet and have an outside diameter equal to cast iron pipe. PVC pipe shall have standard dimension ratio (SDR) of 18.0 or less. The pipe shall be rated for a working pressure of at least 150 psi.

B. PVC pipe shall be manufactured with an elastomeric-gasket joint conforming to ASTM-D 3139. Pipe ends shall be beveled.

C. Fittings for PVC water main shall be cast iron or ductile iron as specified in 1.02.

D. The Contractor shall provide all necessary adapters for connecting PVC pipe to cast iron fittings and valves or other pipelines. Adapters shall be as recommended by the pipe manufacturer.

E. PVC pipe shall be delivered and stockpiled in unit pallets. Store pipe on flat surface. No stacking of pallets of random lengths above five (5') feet in height will be allowed. If pipe is stockpiled for more than 30 days prior to installation in the trench, it must be suitably covered with reflective materials to protect the pipe from ultraviolet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.

F. Bowed sections of pipe will not be acceptable and will not be allowed to be installed on this project.

1.04 BORING AND JACKING OF WATER MAINS

A. Where possible, an approach trench shall be excavated far enough to provide a jacking face of at least three (3') feet from a pavement surface. This open face shall be shored securely to prevent slipping or raveling of the face.

B. Boring pits shall be large enough to contain all necessary equipment and tools. Adequate provision shall be made for the removal of excavated material.

C. A substantial backstop of heavy timber or steel beams shall be provided to take the thrust of the jack or boring equipment.

D. As material is excavated or bored ahead of the pipe, the pipe shall be jacked in to follow this excavation. The distance dug ahead of the pipe shall not exceed six (6") inches.

E. The installation of casing pipe and the boring or excavation shall be done simultaneously.

F. Voids between the sleeve and excavation shall be filled by pressure grouting.

G. Cement grout shall be used to seal the pipe ends between the carrier pipe and sleeve.

H. A one (1") inch PVC pipe shall be installed in the downgrade seal to permit drainage.

I. Steel pipe sleeve shall be furnished in random lengths of the diameter shown on the plans and noted in the proposal and shall conform to the requirements of AWWA C-200; Grade B pipe shall be used. The pipe, including field connections, shall be coated with bitumastic compound, inside and outside. Pipe thickness for 18-inch dia. sleeve shall be 0.313 inches. 12-inch diameter sleeves shall be 0.250 inches thick. All joints for casing pipe shall be made by continuous weld completely around the perimeter of the pipe in accordance with AWWA C-206.

J. Carrier pipe shall be Class 50 ductile iron at each location as required by the plans except at railroad crossing use extra heavy duty and meet railroad specifications.

1.05 GATE VALVES AND BOXES

A. Gate valves shall be resilient seat type, in accordance with AWWA C-509. Valve bodies and bonnets shall be cast iron epoxy coated on the inside per AWWA C-550.

B. Stem and wedge nuts shall be bronze. Stems shall be sealed by at least two O-rings. Seals shall be replaceable with the valve fully open and while subject to the rated pressure. Valves shall open counter clockwise.

C. Wedge shall be constructed of ductile iron fully encapsulated in synthetic rubber except for guide and wedge nut areas or it shall have a replaceable internally reinforced, contoured molded rubber disc seat ring attached to the face of the wedge with self-locking stainless steel screws. Wedge rubber shall be molded in place and bonded to the ductile iron portion. Wedge shall seat against accurately formed seating surfaces in the valve body.

D. Waterway shall be smooth and shall have no depressions or cavities in seat area where foreign material can lodge and prevent closure or seating.

E. Gate valves shall be manufactured by American Flow Control.

F. Provide each gate valve with a 5-1/4 inch dia. Buffalo screw type valve box with "Water" cast in the lids. All boxes for 4, 6 and 8 inch valves shall be equipped with #6 round base. 10 inch valves shall be used with #8 valve box base. Valve boxes shall be adjustable between 2'-4" and 3'-4" except when deeper settings are required. Lids shall be extra deep and have two holes for removal of lid. Valve boxes shall be as manufactured by Mueller.

G. Provide socket valve operating wrenches.

1.06 TAPPING SLEEVE AND VALVE

A. Tapping sleeves shall be of all stainless steel construction including sleeve, bolts and nuts. Sleeves shall wrap 360° around the pipe with gridded full circumference gasket. Units shall be FAST Model by Ford Meter Box Co.

B. Tapping valves shall be cast iron, as manufactured by American Flow Control.

C. Install tapping sleeve and valve per manufacturer's recommendations.

1.07 FIRE HYDRANTS

A. Fire hydrants shall be per Town of Bridgeville Standards. Hydrants shall be compression type with a 5-1/4 inch main valve opening, two 2-1/2 inch hose nozzles, one 4-1/2 inch pumper nozzle and a 6 inch mechanical joint hub base. Hydrant seats shall be provided with bronze to bronze threaded connections.

B. All nozzle and steamer nozzles threads for Town of Bridgeville shall conform to National Standards. Hydrants shall be of proper length for a 4 foot trench depth or as required by field conditions and be American Darling B-62-B. They shall meet the requirements of AWWA C-502.

C. A sworn certificate of inspection and testing shall be furnished by the manufacturer. Install hydrants with restraint system as detailed on the drawings.

D. All hydrants to be furnished with non-kinking chains on the 2-1/2 inch nozzles.

E. Hydrants shall open by turning the operating nut counterclockwise.

F. Fire hydrants to receive one (1) coat of primer and two (2) coats of chrome yellow paint in accordance with Federal Standard 595A. The final coat shall be field applied after the hydrant has been installed.

G. Provide hydrant operating wrenches and repair kits.

H. Hydrants shall be flow tested and color-coded accordingly.

1.08 LAYING WATER MAINS, FITTINGS AND APPURTENANCES

A. Water main pipe, fittings and valves shall be installed per manufacturer's printed instructions. Care shall be taken to insure that no joints are made with unevenness or rough edges. Pipeline deflection must be kept below the manufacturer's limitations.

B. All pipes shall be bedded on a solid foundation prior to backfilling. Defects due to settlement shall be corrected by the Contractor at his own expense. Bell holes shall be dug sufficiently large to receive same.

C. Pipe and fittings shall be kept clean until final acceptance of the work. All open pipe ends shall be provided with plugs to keep dirt, water and other materials from entering. This plug shall be kept in place when actual pipe laying is not in progress.

D. Excavation and backfill for water mains and appurtenances shall be per Section 2A of these specifications.

E. PVC pipe shall be beveled before making pipe joint.

F. Install no pipe on frozen or frost penetrated subgrade. When directed, the Contractor shall install pipe on artificial foundations. Such foundation may consist of gravel or concrete and shall be to the dimensions and in the manner directed by the Engineer.

G. Pipeline detectable tape shall be installed continuously along all PVC water mains. The tape shall be installed directly above the water main and 12 inches from the ground surface. The tape shall be Lineguard Type II Detectable Tape as manufactured by Lineguard, Inc. of Wheaton, Illinois or equal. The tape shall be a minimum of 2 inches wide, blue in color, imprinted with the words "CAUTION -- WATER LINE BELOW" and be capable of being detected with inductive methods.

H. All concrete required to construct buttresses behind plugs, tees, bends and other fittings and anchorages beneath vertical bends shall be placed as directed and/or as shown on the details.

I. Water mains piping shall be accompanied by a No. 14 solid copper wire, which shall be installed along side the pipe continuously and terminate inside a separate and vacant valve box that is near each valve occupied valve box. Wire must terminate at the top of the valve box and be of sufficient length at each valve box to allow adjustment of the box to proposed grade and to allow Utility Locator to energize wire from outside of the box. The purpose of the wire is to allow Locator to energize, trace and locate underground plastic pipe without excavation. Water main wires shall be connected to service pipe wires for continuity by splicing with heat butt connectors (shrink and epoxy seal) or other methods as approved by the Town of Bridgeville.

J. Water mains shall be laid 10 feet horizontally from any existing or proposed sewer. The distance should be measured edge to edge. All water lines should be buried to a depth of at least 3 feet (36 inches). Water mains crossing sewers shall be laid to provide a minimum vertical distance of eighteen (18) inches between the outside of the water main and the outside of the sewer, and the water main shall be above the sewer. At crossings, one full length of water pipe should be elevated so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required. If this minimum vertical separation cannot be provided, either the water line or the sewer line shall be encased for a distance often (10) feet on either side of the crossing.

K. Water mains and storm drains shall be minimum of one (1) foot separation at crossings.

1.09 INSTALLING FITTINGS, HYDRANTS, GATE VALVES AND VALVE BOXES

A. Fittings, hydrants, gate valves and valve boxes shall be placed along the water mains at the locations indicated on the drawings or where otherwise designated by the Engineer.

B. A valve box shall be carefully placed over the bonnet of each gate valve with the top at the finished surface of the street, sidewalk or at such other elevations as the Engineer shall direct. It shall be set exactly plumb. In tamping the backfill around the box special care shall be taken to keep the box plumb and to have it firmly supported on two 4-inch thick solid concrete blocks so as to avoid settlement. Any box which is found out of plumb or which is not firmly supported, shall be excavated and reset in a satisfactory manner, at the Contractor's expense. Place gravel in and around valve box bases to provide for drainage.

C. Ductile iron pipe with cast iron or ductile iron fittings shall be used exclusively throughout the hydrant assembly. The use of PVC pipe will not be permitted in construction of any portion of the hydrant leads. Rod all hydrants to the main as detailed herein.

1.10 DISINFECTION OF WATER MAINS

A. Upon completion of water main construction, disinfect main and appurtenances. Disinfection shall be done in accordance with ANSI/AWWA C-601, latest addition. Contractor shall submit a plan of disinfection for approval by the Engineer.

B. After the applicable retention period, the heavily chlorinated water shall be flushed from the main. This water shall be discharged to the sanitary sewer system or shall be dechlorinated at the hydrant via approved methods and discharged to a storm drain. Only after water leaving the main is no higher in chlorine concentration than normal drinking water will a discharge to storm drains be allowed. Convey flushed water to discharge point in a closed system.

C. Affidavits of compliance, certifying the water sampled from the water mains to be free of coliform bacteria, shall be submitted to the Engineer. The Contractor is responsible for requesting tests from the Delaware Department of Public Health. He shall provide written documentation when a section of mains can be placed in service.

D. The Contractor shall place in each length of pipe, hydrants, hydrant branches and other appurtenances, a sufficient amount of HTH granules to insure adequate disinfection treatment of the main after its completion.

E. The Contractor will be held entirely responsible for securing a minimum residual chlorine content of 5 ppm at the extremities of the mains after twenty-four (24) hours or more contact with the full water pressure on the main.

F. Water for filling the mains shall be introduced at a velocity of less than one (1') foot per second in order to permit the HTH or Perchloron to completely dissolve and have a reasonable uniform distribution throughout the mains. It is the intent of this Specification to require a sufficient amount of chemical to be equivalent to a dosage of 50 ppm of chlorine.

G. After the chlorine has been in contact with the mains or storage units for twenty-four (24) hours or longer, samples collected from the extremities of the mains shall indicate a residual chlorine content of 5 ppm or more.

H. If less than 5 ppm residual chlorine is indicated, the system shall be drained and the disinfection treatment repeated.

I. If samples collected at the extremities indicate a residual chlorine of 5 ppm or more, the system shall be flushed until there is only a normal chlorine residual (1.0 ppm or less) present, as determined by the DPD Method Test. Samples of water shall be collected from various points along the lines, by the State for bacteriological analysis. If satisfactory bacteriological results are obtained, the lines may then be allowed to be placed in service. A copy of all test results shall be submitted to the Engineer.

J. Dechlorinate all testing water and safely dispose of. Disposal rate and location shall be approved by the Town Public Works Director.

1.11 WATER MAIN TESTING

A. Equipment, Labor and Materials for Testing

The Contractor shall furnish all equipment, labor and materials, including water, pumps, compressors, stopwatch, gauges and meters as approved by the

Engineer for testing. The Engineer shall determine the amount of main to be tested at any one time and reserves the right to separate the installation into several test sections. All tests must be witnessed by the Engineer or Town.

B. Pressure Test

After the pipe has been laid, all newly laid pipe or any valved section thereof, shall be subjected to a hydrostatic pressure of 125 psi.

1. Test Pressure shall:

   a. Be of at least two hour duration.
   b. Not vary by more than +/- 5 psi.

2. Pressurization. Each valved section of pipe shall be filled with water slowly and to the specified test pressure, based on the elevation of the lowest point of the line or section under the test; corrected to the elevation of the test gage and shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Town.
3. Air Removal. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants. <u>If permanent air vents are not located at all high points</u>, the Contractor shall install corporation cocks at such points, so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, all corporation cocks shall be removed and plugged or left in place at the discretion of the Town.
4. Examination. All exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with same material and the test shall be repeated until it is satisfactory to the Town.

C. Leakage Test

A leakage test shall be conducted concurrently with the pressure test.

1. Leakage Defined. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or at any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.
2. Allowable Leakage. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{ND \text{ square root of } P}{7400}$$

in which L is the allowable leakage, in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches, and P is the average test pressure during the leakage test in pounds per square inch gage.

Allowable leakage at various pressure is shown in Table I (appearing below).

3. When hydrants are in the test section, the test shall be made against the closed hydrant.

D. Should the tests show the main to be defective, the Contractor shall remedy such defects and retest the main as specified above. This procedure shall be repeated until the test requirements are met.

TABLE I

Allowable Leakage per 1000 feet of Pipeline* - gph

Nominal Pipe Diameter - inch

Avg. Test Pressure psi	2	3	4	6	8	10
150	0.19	0.28	0.37	0.55	0.74	0.92
125	0.17	0.25	0.34	0.50	0.67	0.84
100	0.15	0.23	0.30	0.45	0.60	0.75

*For pipe with 18-ft. nominal lengths.

To obtain the recommended allowable leakage for pipe with 20-ft. nominal lengths, multiply the leakage calculated from the Table by 0.9.

If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

1.12 SERVICE PIPE AND APPURTENANCES

A. General

1. For all new residential or commercial developments currently not served by the Town of Bridgeville, the Contractor is responsible for furnishing and installing all stub outs corporation stops, house service pipe, meter setters or prefabrication meter setters, covers, valves and appurtenances as indicated on the drawings and specified herein.

   The meter setters installed by the Contractor shall accommodate the following meters for installation by Town:

   a. Single Family residential hook-up; Sensus Model iPerl 5/8" x 3/4" TRPL, MXU Radio Read.
   b. Multi Family, apartment, light commercial hook-up; Sensus iPerl TRPL, MXU Radio Read.
   c. Commercial hook-up; 2" meter flanged Sensus Omni R2 TRPL with Touch Read System and radio read MXU.

2. The Contractor shall provide all tools, equipment and accessories required for tapping ductile iron and polyvinyl chloride water mains and installing water services. All underground service lines, valves and fittings shall conform to ANSI/AWWA C800-84.
3. Detectable tape approved by the Engineer shall be placed directly over all water services during backfilling operation so magnetic detection of service lines may be utilized in future by the Town.
4. Install No. 14 solid copper tracer wire from the meter pit to water main tracer wire.

B. House Services

1. Standard water service lines shall be polyethylene, 1 inch diameter, SDR-9 copper tube size unless otherwise approved or required by the Town. Service lines shall conform to AWWA C-901 and ASTM D-2737.
2. Corporation stops shall be 1 inch, AWWA/CC taper thread inlet by pack joint outlet for plastic tubing (CTS), Ford F1000-4 or approved equal. Install stainless steel liner at compression connections to plastic service line. Liners shall be Ford Insert-52 or approved equal.
3. Cutting tools shall be of the hollow, shell bit type for removal of pipe plug. For tapping PVC mains use only Mueller Plastic Cutting Tool. On multiple taps, place corporation stops as recommended by pipe manufacturer. Furnish saddles with standard AWWA/CC corporation stop tapered inlet thread. Saddles shall be Ford banded stainless steel type FS303 or approved equal for AWWA/C900 PVC water mains and Ford double strapped type FS202 or approved equal for iron water mains.
4. Meter box covers shall be Ford A32-T for single meter setters and Ford A3-TT for dual meter setters, or approved equals. For meters set in traffic areas contractor shall furnish and install extra heavy lids Ford WA3L-T for single meter setters and Ford WA3L-TT for dual meter setters, or approved equals. Lids shall be inset cast iron with the words "WATER METER" and holes for remote reading precast into them. Lids shall include lifter worm locks with a standard pentagon bolt. Frames shall be 4" in depth. Six meter box lid wrenches will be supplied to the Town. Contractor shall verify fit and compatibility of assembly components prior to ordering.
5. Prefabricated meter box assemblies shall be installed in locations approved by the Town. The box shall be 18" I.D. x 36" PVC for single meter setters and 20" I.D. x 36" PVC for dual meter setters. Meter support shall be by a lateral PVC brace. For 5/8" x 3/4" meter pit assemblies angle check valve shall be Ford HA 31-323. System shall also include an angle ball valve with lock wings. Valve shall be Ford BA13-332W. Coupling for inlet connection shall be 3/4" F.I.P. x 1" P/J CTS Ford C14-34 with stainless steel insert. Coupling for outlet connections shall be 3/4" F.I.P. x 1" P.J. CTS Ford C14-33 with stainless steel insert.

C. Commercial Service

1. All commercial services shall be Schedule 80 PVC (IPS) or SDR-9 CTS polyethylene tubing.
2. For 2"-3" taps in ductile iron pipe use double strap, iron service clamp

Ford FS202 or approved equal. For 2"-3" taps in PVC pipe use Ford, stainless steel banded saddle FS303 or approved equal. For taps 4" and larger use Ford steel tapping sleeve with stainless steel bolts and epoxy coating. Use Teflon tape and brass nipple for threaded service connections. Do not torque saddles or sleeves without water pressure in main.

3. Use Mueller 2 inch iron pipe thread or 2 inch Ford ball valve no. B11-777. Valve boxes shall be 5-1/4 inch Mueller roadway screw type with arch base.
4. Meter pits and setters shall be as detailed on the approved plans. Pits shall be PVC. Covers shall be MC-30-T by Ford, or approved equal, with lifter worm lock and precast hole for remote reading. Provide double extra heavy covers for traffic areas. Setters shall be Ford custom type with 2 inch angle flg. check valve, 2 inch flg. angle ball valve plus a bypass ball valve with padlock wings.

D. Gang Meter Pits (Up to Five (5) Meters)

1. All service lines connecting gang meter pits to water mains shall be 2-inch Schedule 80 PVC threaded service pipe (IPS) or 2-inch SDR 9 CTS polyethylene tubing. The main fold in the pit shall be Schedule 80 PVC pipe. The service pipes downstream of the pit shall be polyethylene tubing SDR 9 CTS, 1 inch diameter.
2. The gang meter shall be installed in a precast concrete meter pit by Penn-Cast Products, Inc., Model #448, or approved equal, top section only. The service pipe or tubing must be installed through a wall sleeve.
3. Tapping shall be as specified for 2" taps in section 1.12C of these specifications.
4. Curb valve shall be Mueller 2-inch oriseal valve H-10291 or 2 inch Ford ball valve with iron pipe thread B11-777 or approved equal. The valve box shall be 4-1/4 inch Mueller roadway screw type with arch base.
5. The setting shall be as detailed on the plans. Use Ford yoke Y502P, Ford straight yoke ball valve B91-324W, Ford straight yoke check valve HS91-323, P/J coupling Ford C84-34 and Ford expansion connection EC-23W.
6. Cover shall be Ford MC-30T with 20-inch lid and 30-inch inside diameter.
7. For gang pits of more than five meters, see special Town detail sheet.

E. Laying Service Pipe and Appurtenances

1. All service pipe shall be carefully inspected for damaged areas. All damaged pipe shall be cut out and recoupled. Pipe installed during hot weather shall be allowed to contract to normal length before backfilling. Pipes and fittings shall be bedded on a solid foundation.
2. Fittings and valves shall be kept clean, handled carefully and installed according to the manufacturer's recommendations.
3. All new service lines shall be installed in the center of vacant lots to the property line and not driveways, unless otherwise directed by the Engineer or Town.
4. Service lines in streets shall be installed by open cutting or with an underground piercing tool such as an ACCU-punch or equal. Maximum diameter of piercing tool to be 2-1/2 inches. Based on bids received, the

Town may adjust the quantity of the various types of service installation or eliminate the use of the piercing tool as is in his best interest.

5. Installation of services by piercing tool shall be performed with all necessary devices to assure alignment accuracy. Such devices shall include a magnetic level, launcher and aiming frame. The Contractor shall demonstrate installation procedures to the Engineer and the D.O.T. for approval prior to use.
6. Service connections and meter boxes shall be installed immediately after the construction of the adjacent main. Postponement of construction of service lines will not be allowed.
7. Requirements for sterilization and pressure testing of service connections shall be the same as specified for mains in this specification.
8. The Contractor is responsible for locating existing services, cutting and reconnection with all necessary adaptors or sleeves within the unit price bid for service lines. The Contractor shall obtain and pay for the services of a licensed plumber if required by code.

END OF SECTION

SECTION 2C - SEWER PIPE, FORCEMAINS AND APPURTENANCES

1.01 GENERAL

A. The Contractor shall furnish all material and shall construct the pipe lines and all required appurtenances at the locations and to the lines, slopes and elevations shown on the drawings or designated by the Engineer. Materials and equipment must be installed to manufacturer's recommendations. Pipe bells shall be laid on the upstream end. Pipe laying shall commence at the lowest elevation and proceed upstream.

B. All sewer pipe shall be polyvinyl chloride (PVC) pipe.

C. The Contractor shall submit certifications to the Engineer that all pipe, fittings and joints are as specified herein.

D. Pipeline detection tape shall be placed over gravity sewers and a 14 gauge tracer shall be placed over forcemains. The tracer wire shall terminate in a separate, dedicated "valve box" (no valve in this valve box).

1.02 POLYVINYL CHLORIDE SEWER PIPE AND FITTINGS

A. Polyvinyl chloride (PVC) pipe, used for sewer construction, shall equal or exceed the requirements of ASTM D-3034 and shall have a minimum standard dimension ratio (SDR) of 35 and the minimum pipe stiffness, as tested in accordance with ASTM D-2412, shall be 45 when measured under five (5%) percent deflection at 73 degrees Fahrenheit. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding twenty (20') feet.

B. All PVC pipe and fittings shall utilize an elastomeric O-ring gasketed joint conforming to ASTM 0-1860 assembled in accordance with the manufacturer's recommendations.

C. PVC wye branches, pipe stoppers and other fittings shall be manufactured in accordance with the same specifications and shall have the same thickness, depth of socket and annular space as the pipe. Tee fittings will not be permitted for use. Wye branches shall be complete pipe sections. Saddles will not be permitted for use.

D. PVC pipe shall be delivered and stockpiled in unit pallets. Stacking of pallets above five (5') feet in height will not be allowed. If pipe is stockpiled for more than 30 days prior to installation in the trench, it must be suitably covered with reflective material to protect the pipe from ultraviolet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.

E. Bowed sections of pipe will be unacceptable and installation of pipe which has bowed, whether or not the bow has been corrected, will not be allowed.

1.03 POLYVINYL CHLORIDE FORCE MAIN PIPE AND FITTINGS

A. Pipe shall be manufactured to meet the requirements ASTM D-1785 PVC

pressure pipe SDR 21. Pipe shall be manufactured in lengths not exceeding twenty (20') feet. Pipe shall be integral bell by plain end design.

B. All pipes to be connected by solvent welding shall be installed by experienced pipe layers, to the satisfaction of the Engineer. Jointing shall be done in the manner recommended by the manufacturers. The PVC-compound shall meet ASTM D-1784 requirements.

C. Pour concrete thrust blocks according to the details on all horizontal or vertical pipe bends.

D. The force mains shall be filled with water, supplied by the Contractor, as directed by the Engineer and the pressure raised to obtain a minimum test pressure of 75 psi measured at the highest point of the section of pipeline under test. Particular care shall be taken to eliminate all air from the pipeline. The force mains shall be subject to a leakage test at the specified test pressure, measured at the highest point of the section of pipeline under test. This test shall be a minimum of four (4) hours duration during which time the leakage shall not exceed 25 gallons per inch of diameter per mile in 24 hours and this is not to include any visible leaks. All visible leaks shall be repaired by the Contractor at no expense to the Town. The Contractor shall make any and all repairs at his expense that may be necessary until the leakage test requirements have been met. The test pressure for the force main shall be 75 psi.

1.04 PIPE INSTALLATION

A. Pipe and fittings shall be carefully handled and lowered into the trench. Special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipe.

B. Before pipe is placed, the bottom of the trench shall be carefully shaped to fit the lower part of the pipe exterior with reasonable closeness for width of at least 60% of the pipe width. Bell holes shall be dug sufficiently large to insure the making of proper joints and so that after placement, only the barrel of the pipe receives bearing pressure from the trench bottom. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Any defects due to settlement shall be made good by the Contractor.

C. Proper and suitable tools and appliances for the safe and convenient handling and laying of pipe shall be used.

D. Whenever a pipe requires cutting to fit into the line or to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end.

E. The pipes shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. The open ends of all pipe lines shall be provided with a stopper carefully fitted so as to keep dirt and other substances from entering. This stopper shall be kept in the end of the pipe line at all times when laying is not in actual progress.

F. All concrete required to support and reinforce wye branches, bends and other fittings shall be placed as directed, and the cost thereof shall be included and covered within the price bid.

G. Backfill materials shall be hand placed and mechanically tamped in six (6") inch layers, placed uniformly on both sides of the pipe to a point at least one (1') foot above the pipe crown. Each layer shall be thoroughly compacted for the full trench width and under, around and over the pipe.

H. Pipeline detectable tape shall be installed continuously along all sewer mains. The tape shall be installed directly above the pipe and twelve (12") inches from the ground surface. The tape shall be Lineguard Type II Detectable tape as manufactured by Lineguard, Inc. of Wheaton, Illinois or equal. The tape shall be a minimum of two (2") inches wide, imprinted with the words "CAUTION -- SEWER LINE BELOW" and be capable of being detected with inductive methods.

I. For refill of the remaining trench depth, refer to "Excavation and Backfill", Section 2A of these specifications.

1.05 LAYING PIPE IN FREEZING WEATHER

No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when the Engineer shall deem that there is danger of the formation of ice or the penetration of frost at the bottom of the excavation unless all required precautions as to the minimum length of open trench and promptness of backfilling are observed.

1.06 ARTIFICIAL FOUNDATION

Whenever directed, the Contractor shall lay pipe upon an artificial foundation which he shall construct. Such foundation may consist of gravels or of concrete; all to be of the form and dimensions and placed according to the detail or in the manner required by the Engineer.

1.07 TESTING

A. Gravity sewer to be tested in accordance with the following:

1. Contractor shall furnish all labor, tools, materials and equipment including water, pumps, compressors, stopwatch, gauges and meters, subject to the approval of the Engineer, for testing in accordance with these specifications.

2. The Engineer shall be notified in advance of all tests, and all tests shall be conducted to his entire satisfaction.

3. The Gravity Sewer shall be mirror and air tested as follows:

a. Mirror Test:

Upon completion of pipe laying and backfilling to a point at least two (2') feet above the crown of the pipe, the Engineer will conduct

a mirror test to check for defects, excess deflection, leakage and for horizontal or vertical misalignment. Mirror testing shall consist of reflecting sunlight or artificial light via mirrors through the completed section of pipeline, which, in order to be accepted, shall be true and straight in horizontal and vertical alignment to allow for the full passage of the reflected light.

b. Leak Testing Using Air:

i. Sewers shall be tested in sections of not more than four hundred (400') foot lengths unless otherwise approved by the Engineer. Each section shall be tested immediately upon completion thereof. Each section shall meet the air pressure drop limitations specified herein.

ii. All material and labor required for leakage tests shall be furnished by the Contractor.

iii. Sewers shall be tested using the low-pressure air method in accordance with the requirements of ASTM C-828 and the Uni-Bell Plastic Pipe Association's recommendations, based upon the Ramseier test time criteria. Procedural and equipment details shall be submitted to the Engineer prior to acceptance of its use for testing.

iv. If the test time for the designated size and length elapses before the test pressure drops 0.5 psig, the section undergoing the test shall have passed.

v. If the pressure drops 0.5 psig before the appropriate test time has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test. Contractor shall determine at his own expense the source or sources of leakage and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

c. Mandrel Testing of Sanitary Sewers

All gravity sanitary sewer pipes shall be mandrel tested as follows. Excepted from this requirement is yard piping used for temporary by-passing.

i. Sanitary sewer pipe shall be deflection tested not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling an approved solid pointed mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the inside diameter of the pipe. The mandrel shall be a rigid, non-adjustable mandrel having an effective length of not less than its normal diameter.

ii. Testing shall be conducted on a manhole to manhole basis and shall be done after the line had been completely

cleaned and flushed. Any portion of the sewer which fails to pass the test shall be excavated, repaired, or realigned and retested with both air and deflection tests.

B. Vertical surveys of inverts of gravity sewers and forcemains shall be conducted and sealed by a Delaware Licensed Surveyor and submitted to the Town within ten (10) days of sewer installation.

1.08 DIRECTIONAL DRILLING

A. Guide Boring Method

Guided boring shall use a surface launched steerable drilling tool controlled from a mobile drilling frame, and include a field power unit, mud mixing system, and mobile spoils extraction system. The drilling frame shall control operations from the surface. The drilling frame shall be sited and aligned to bore a pilot borehole that conforms to the planned installation of the forcemain. The drilling frame shall be set back from the access pit that has been dug and a high-pressure fluidjet toolhead shall use a mixture of bentonite clay and water. Pits shall be dug at the start point and endpoint of the proposed pipe installation and shall be used to align the toolhead, attach other equipment, and to collect and remove excess spoils. An electronic guidance system shall be used, the toolhead shall be guided through the soil to create a pilot borehole. Upon reaching the endpoint pit, the toolhead shall be removed and a reamer with the product pipe attached shall be joined to the drill string and pulled back through the borehole. A vacuum spoils extraction system shall remove any excess spoils generated during the installation. The connections or other appurtenances shall then be completed at a both the start point and endpoint locations and the surface restored to its original condition.

B. Drilling Fluid

Drilling fluid shall be a mixture of water and bentonite clay. The fluid shall be inert. The fluid shall remain in the tunnel to ensure the stability of the tunnel, reduce drag on the pulled pipe, and provide backfill within the annulus of the pipe and tunnel.

C. Equipment

Guided boring equipment shall consist of a surface launched steerable drilling tool controlled from a mobile drilling frame, and include a field power unit, mud mixing system, and mobile spoils extraction system.

The number of access pits shall be kept to a minimum and the equipment must be capable of boring the entire crossing in a single bore. The guided boring system will have the capability of boring and installing a continuous run without intermediate pits.

The guidance system shall have the capability of measuring vertical (depth) position, horizontal position, and roll.

D. Installing Product Pipe

Reaming diameter will not exceed 1.5 times the diameter of the product pipe being installed. The allowable bending radii of the product shall not be exceeded.

Pullback forces cannot exceed the allowable pulling forces for the product pipe, which shall be specified and certified by the pipe manufacturer during the submittal process. In order to minimize joint tension , HDPE pipe shall be filled with water after all HDPE butt fusion has taken place and prior to connecting it with PVC pipe.

The contractor shall allow sufficient extra lengths of product pipe to extend past the termination point to allow connections to adjacent pipe sections. Pulled pipe will be allowed 72 hours of stabilization prior to making tie-ins. Each end of the HDPE pipe installed by directional drilling shall be fitted with a PE Wall anchor ring and a MJ Adaptor. To prevent pullout, Contractor shall install a concrete anchor around the PE Wall anchor ring and shall use restrained joints on bell and spigot pipe within 100' of the HDPE pipe connection.

E. HDPE PIPE FOR DIRECTIONAL DRILLING MATERIAL

1. Materials

a. Materials used for the manufacture of high density polyethylene pipe and fittings shall comply with all requirements of D3350 for 345444C, and have a PPI recommended designation of PE3408. The pipe shall be rated for a working pressure of at least 160 psi plus a surge allowance of at least 150%. Pipe shall be a minimum dimension ratio of DR9, fittings shall be a minimum dimension ratio of DR9. The molecular weight category shall be extra high (250,000 to 1,500,000) as per the Gel Permeation Chromatography determination procedure with a typical value of 330,000.

b. HDPE pipe manufactured from materials meeting the specifications of this section shall have an Environmental Stress Crack Resistance of zero failures when tested to greater than 10,000 hours (ESCR: F_0>10,000) when tested in accordance with ASTM F 1248.

2. Pipe and Fittings

a. Pipe and fittings shall be manufactured from materials meeting the requirements stated above. The manufacturer shall certify that samples of the manufacturer's production have been tested in-house in accordance with ASTM D 2837, and validated in accordance with the latest revision of PPI TR-3.

b. Working Pressure Rating (WPR): The piping system shall be designed to accommodate maximum possible pressure surges. For operating temperatures that do not exceed 80°F (27°C).

c. All pipe and fittings shall meet the testing requirements of the most current version of AWWA C 901 (½" through 3") or C 906 (4" through 63"). Test data shall be furnished by the manufacturer upon request.

d. All fittings shall be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness specifications of AWWA C 901 or AWWA C 906 for the same size of pipe. All fabricated fittings shall be properly rated according to manufacturer's written recommendations, and clearly labeled on the fitting as such. Manufacturer shall have a written specification for all standard fabricated fittings with established quality control criteria and tolerances. The manufacturer of the pipe shall be the manufacturer of the fabricated fittings. Molded fittings shall be made from PE3408 HDPE and have fusion compatibility with the pipe. Pipe manufacturer must certify that they produced the pipe, fabricated the fitting, and provide the warranty.

e. Pipe and fittings may be joined by thermal fusion, electrofusion, flange assemblies, or mechanical methods as described in AWWA C 901 and C 906.

1.09 BORING AND JACKING OF SANITARY SEWER

A. Where possible, an approach trench shall be excavated far enough to provide a jacking face of at least three (3') feet from a pavement surface. This open face shall be shored securely to prevent slipping or raveling of the face.

B. Boring pits shall be large enough to contain all necessary equipment and tools. Adequate provision shall be made for the removal of excavated material.

C. A substantial backstop of heavy timber or steel beams shall be provided to take the thrust of the jack or boring equipment.

D. As material is excavated or bored ahead of the pipe, the pipe shall be jacked in to follow this excavation. The distance dug ahead of the pipe shall not exceed six (6") inches.

E. The installation of casing pipe and the boring or excavation shall be done simultaneously.

F. Voids between the sleeve and excavation shall be filled by pressure grouting.

G. Cement grout shall be used to seal the pipe ends between the carrier pipe and sleeve.

H. A one (1") inch PVC pipe shall be installed in the downgrade seal to permit drainage.

I. Steel pipe sleeve shall be furnished in random lengths of the diameter shown on

the plans and noted in the proposal and shall conform to the requirements of AWWA C-200; Grade B pipe shall be used. The pipe, including field connections, shall be coated with bitumastic compound, inside and outside. Pipe wall thickness for sleeves shall be standard thickness. All joints for casing pipe shall be made by continuous weld completely around the perimeter of the pipe in accordance with AWWA C-206.

J. Carrier pipe shall be as required by the plans.

K. Use runners or cradles to support the pipe in the casing. A minimum of two supports is needed per joint of pipe providing a maximum span of 6-1/4 feet for PVC pipe lengths of 12.5 feet or less. The maximum span between supports for pipe lengths of 19 to 20 feet must not exceed 7.5 feet.

1.10 SEWER MANHOLES

A. General

1. The Contractor shall have the option of constructing shallow (4' or less) manholes of precast reinforced concrete or "SS" sewer brick as indicated on the drawings. Manholes deeper than four (4') feet will be precast reinforced concrete.

2. Manholes shall be built at such points on the pipe lines and of such form and dimensions as are shown on the drawings or as may be directed. Manholes shall be built as pipe laying progresses and the Engineer may stop work entirely on the laying pipe if manhole construction is delayed to such an extent as to be hazardous to construction or the public.

3. Manhole frames and covers shall be installed on grade to match the slope of the paved surface. Use brick or premanufactured devices, approved by the engineer, to build up from cone to grade as required to match the slope of the frame and cover to the slope of the paved surface.

B. Precast Reinforced Concrete Manholes

1. Precast reinforced concrete risers, eccentric cones and bases shall be in conformance with ASTM Designation C-478. Joints between riser sections shall be fitted with an "O" ring rubber gasket, meeting the requirements of ASTM Designation C-443. Installation of risers shall be in accordance with manufacturer's recommendations under the supervision of the Engineer.

   Minimum compressive strength of precast concrete shall be 4000 PSI in 28 days.

2. Precast reinforced concrete base and riser sections shall be as manufactured by Atlantic Concrete Products Company, Virginia Precast Corporation or equal.

3. Interior and exterior joint spaces of all manhole risers shall be filled prior to application of the exterior waterproofing. The interior joint shall be

mortared. The exterior joint may be mortared or filled with a joint filler compound. Said compound shall be Pioneer 301 as manufactured by Daubert Chemical Co., Oakbrook, Illinois or equal.

4. Lifting holes in the walls of precast reinforced concrete risers will be allowed but shall be plugged with rubber stoppers and grouted flush with face or manhole wall after installation of manhole riser sections. Not more than two holes shall be cast in the walls of each riser section for the purpose of handling.

5. The exterior surface of all precast manholes shall receive a minimum two (2) coat application of a sixty eight (68%) percent solids coal tar type protective coating. The total average dry film thickness shall measure 24 mils with no single measurement to be less than 20 mils. Surfaces shall be prepared in accordance with the manufacturer's instructions and coatings applied in the field in a manner acceptable to the Engineer. The coating material shall be Bitumastic Super Service Black manufactured by Koppers Co., Inc., Pittsburgh, Pennsylvania, Tar-Jet Super Black XX-32-B-22 manufactured by Pennsbury Coatings Corp., New Britain, Pennsylvania or equal.

6. All pipe-to-manhole connections in the precast manhole shall be made by means of an integrally cast flexible connector which shall be Lockjoint flexible manhole sleeve as manufactured by Interpace Corp., Parsippany, New Jersey or A-Lok flexible manhole gasket as manufactured by A-Lok Corp., Trenton, New Jersey or equal.

C. Flow Channels

1. All manhole flow channels and benches shall be constructed of "SS" sewer brick with care taken to secure smooth and even surfaces with full special mortar joints. Channel sections shall be built up to true line and radius and curved sections shall provide a uniform transition in the flow direction.

2. Materials and construction of flow channels shall be in accordance with appropriate sections for materials so used, as hereinafter specified.

D. Concrete

All concrete for manhole base slabs and cradles, encasements, blocking, etc. shall have a minimum compressive strength of 3,000 psi at 28 days.

E. Brick

All brick shall conform to the "Standard Specifications for Sewer Brick", ASTM Designation C-32, Grade SS, except that the maximum absorption for the average of five (5) bricks shall not exceed ten (10%) percent and the individual brick maximum shall not exceed fourteen (14%) percent.

F. Mortar

1. Cement shall be in accordance with the "Standard Specifications for Portland Cement", ASTM Designation C-150 for Type II.

2. Sand shall be composed of sharp, angular, silicious grains, coarse or graded from fine to coarse with the coarsest grains predominating, and sensibly free from clay, loam, dirt, mica, organic matter or other impurities. Sand containing more than five (5%) percent by weight of foreign material shall not be used. This limit may be changed for special classes of work if hereinafter specified. Sand exhibiting more than an acceptable amount of fine matter or impurities may be required to be washed after delivery on the work or shall be rejected altogether. Sand for mortar shall be screened to reject all particles of a greater diameter than 1/4-inch and shall not contain more than five (5%) percent by weight of a very fine material.

3. Unless hereinafter specified otherwise, all mortar shall be composed of cement and sand of the character above specified. The proportion of volume shall be one part of cement to two of sand. One volume of cement shall be 94 pounds net. One volume of sand shall be 0.9 cubic feet, the sand not being packed more closely than by throwing it into a box in the usual way. Mortar shall be fresh mixed in small batches for the work in hand. Tight boxes or platforms made for the purposes shall be used. The sand and cement shall be thoroughly mixed dry, in the proper proportions, until a uniform color has been produced, whereupon a moderate dose of water shall be added, so as to produce a stiff paste of the proper consistency.

4. Sand obtained from the excavation shall not be used.

G. Laying Brick

1. All brick work shall be laid by competent professionals.

2. All brick shall be laid in a full bed of mortar with all vertical and horizontal joints filled solid with mortar.

3. Joints shall be not less than 3/8-inch or more than 1/2-inch wide except as otherwise specified in (E) below.

4. No brickwork shall be laid when the temperature is below 40 degrees or when the indications are for lower temperatures within 24 hours. The Contractor shall take such measures as may be approved to prevent brick work from being exposed to freezing temperatures for a period of not less than five days after laying.

5. Special care shall be taken in laying brick in inverts of manholes to insure a uniform flow of water through the sections. In such locations, joints shall not exceed 1/16-inch in thickness and each brick shall be laid in full mortar bed with joints on bottom side and end made in one operation. No grouting or working in of mortar after laying the brick will be permitted.

H. Manhole Steps

1. Manhole steps shall be made of 3/8-inch diameter (No. 3) steel reinforcing bars, ASTM Designation A-615, Grade 60, encased in polypropylene plastic. Manhole steps shall have notched tread ridge with retainer lug on each side.

2. Manhole steps shall be cast-in-place during manufacture of precast reinforced concrete manholes or placed in brick manholes during construction. Embedment length shall be suitable for minimum five (5") inch thick, precast reinforced concrete riser walls.

3. Manhole steps shall be OSHA approved and as manufactured by M.A. Industries, Inc., Peachtree City, Georgia, ICM, Inc., Jacksonville, Arkansas or equal.

4. Manhole steps shall be spaced twelve (12") inches apart. The maximum spacing from top of manhole to the first step shall not exceed sixteen (16") inches.

I. Manhole Frames and Covers

1. Frames and covers for manholes shall be set by the Contractor as the work progresses. The frame shall be well bedded in mortar.

2. Frames and covers shall be Neenah R-1642, solid lid with "SANITARY SEWER" and two (2) pick holes cast in the cover. Material for frames and covers shall be in accordance with standard specifications for gray iron castings ASTM A-48 for Class 35.

3. In areas subject to flooding inclusive of low street areas, furnish Parsons manhole inserts with Naylon Handles and factory installed gasket.

4. Manhole stubs shall be extended four (4') feet outside of the manhole wall unless otherwise detailed. The stub end shall be plugged.

5. Manhole frames and covers shall be installed on grade to match the slope of the paved surface. Use brick adjustment courses or manufactured adjustment rings grouted in place between the cone and frame for adjustment to match the slope of the paved surface.

J. Tests

If inspection reveals any visible leakage or seepage in any manhole, the Contractor will be required to accomplish such remedial measures as may be directed by the Engineer. Caulking or patching of interior manhole surfaces will not be acceptable.

K. Existing manholes to receive a new pipe shall be core drilled. Oversize the hole and install a water stop grout ring by Press-Seal Gasket Corporation, or approved equal. Seal with a non-shrink grout. Modify flow channel.