DESIGN CRITERIA
AND
CONSTRUCTION SPECIFICATIONS

DIVISION II
WATER & SEWER SYSTEMS

February, 2010

DEPARTMENT OF ENGINEERING

TOWN OF WINDSOR,
STATE OF COLORADO

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FORWARD

This Town of Windsor's **Design Criteria and Construction Specification, Volume II, Water and Sewer Systems**, document is intended to provide guidance for the design, review, and construction of those water and sewer system improvements in or under the public right-of-way and public easements. These Standards shall be required for all water distribution system and/or sanitary sewer collection system projects within the Town limits of the Town of Windsor and its Growth Management Area (GMA) that are a part of the water and/or sewer system under the control of the Town of Windsor.

This document represents an attempt to assist those in the design, review, and construction industry in providing quality and long-lasting public improvements. The document also provides for consistency in the design, review, and construction areas.

The document is not intended to replace or restrict the design function of the engineer nor the innovativeness and expertise of developers and contractors. Users of this document are encouraged to submit their ideas and methods of improving the document.

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Dennis Wagner, P.E.
Town Engineer

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TOWN OF WINDSOR, COLORADO

DEPARTMENT OF ENGINEERING

DESIGN CRITERIA

AND

CONSTRUCTION SPECIFICATIONS

DIVISION II

WATER and SEWER SYSTEMS

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DIVISION II

WATER DISTRIBUTION and SANITARY SEWER COLLECTION SYSTEMS

WATER and SEWER

DESIGN CRITERIA and CONSTRUCTION SPECIFICATIONS

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SECTION 1
MINIMUM DESIGN CRITERIA

1.01 SCOPE

The purpose of this section of this document is to present the Town of Windsor criteria for the design of potable water distribution systems and sanitary sewer collection systems. It is to be used by developers, design architects, and design engineers in the design of public and private water and sewer systems for which approval by the Town of Windsor Engineering Department and Public Works Department is required. All water and sewer system design, layout, alignment, and development shall conform to these design criteria, the Town of Windsor Subdivision Regulations, the Town of Windsor Comprehensive Plan, the Town of Windsor Water Master Plan, the Town of Windsor Sewer Master Plan, and all applicable Chapters of the Windsor Municipal Code.

1.02 GENERAL

A. MINIMUM STANDARDS

1. The provisions stipulated in this section are general in nature and shall be considered as applicable to all parts of these specifications, including any supplements and revisions. All waterline and sewer line construction within the public right-of-way or dedicated easement areas shall be designed by or under the direct supervision of a Professional Engineer (P.E.) registered in the State of Colorado. All drawings and support data submitted to the Town for approval must bear their seal and signature. No permits for construction will be issued until these documents have been certified by a P.E. and approved by the Town.

2. The design criteria as presented is intended to aid in preparation of plans and specifications for the Town of Windsor including minimum standards where required. These design criteria are considered minimum and a complete design will usually require more than is presented in this document. As with any design criteria, occasions may arise where the minimum standards are inappropriate. In these cases a variance shall be considered. Written request for each variance should be directed to the Town Engineering Department and shall conform to the requirements of **Section 1.03B.1**.

3. Whenever the provisions of these Standards are found to be inconsistent with any other regulations or codes, the Town Engineer shall determine the standard to apply. In the case of uncertainty or conflicts with other standards or regulations, the most restrictive requirement should be considered to apply. The provisions of these regulations are minimum requirements that do not preclude imposition of more restrictive standards by agreement or by law.

4. Projects shall comply with all laws, regulations, codes, and ordinances applicable to the design and the furnishing and performance of the work. Except where otherwise expressly required by applicable laws, regulations, codes or ordinances, the Town shall not be responsible for monitoring compliance with any law, regulation, code or ordinance.

5. The Town has subdivision regulations and development code that can help define the various processes required for projects.

6. Prior to the Contractor beginning work, an approved set of plans and specifications must be on file with the Town of Windsor and a pre-construction conference shall have been held. All contracts, bonds, insurance, permits, and licenses must be fully executed by the Contractor before beginning work. Contractor shall have a copy of these standards and specifications on the site at all times during construction.

7. Town's review and approval will only be to determine if the plans, specifications, and construction conform to the Town's requirements. Town's review and approval will not relieve the Design

Professional and Contractor/Owner from responsibility for any variation from the Town requirements or adequate design standards. The Town's review and approval shall not constitute any assumption of responsibility or liability for the design or construction and the Town's review and approval of any plans, reports, or drawings or the Town's inspection and approval of any improvements constructed by the Developer in accordance with these Standards, does not constitute a representation, warranty, or guarantee by the Town that such improvements are free from defects or will operate adequately for the purpose intended.

8. It is the intent and purpose of these standards and specifications to obtain high quality construction throughout, with the completed work complying with the standards and specifications. The provisions of these Criteria and Standards are minimum requirements that do not preclude the use of more restrictive standards by the Design Engineer.

9. Reference to standard specifications, manuals, or codes of any technical society, organization, or association or to the laws or regulations of any governmental authority, whether such reference is specific or by implication, shall mean the latest standard specification, manual, code, or laws or regulations in effect at the time of Town's acceptance. However, no provision of any referenced standard specification, manual, or code shall be effective to change the duties and responsibilities of the Town or any of their consultants, agents, or employees from those set forth in these Standards and Specifications. Work shall be done in compliance with the accepted plans and to the satisfaction of the Town.

10. Consideration shall be given, within the established framework of the water distribution and/or sewer collection system, to provide for uniformity of water and sewer mains and appurtenances, proper alignment, material specifications, and conformity to existing systems. The water system design shall be directly related to the water demand needs. The sewer collection system design shall be directly related to the expected sewage flow demands. The water distribution system and sewer collection system and appurtenances shall be designed to provide for the safety of homeowners, motorists, pedestrians, and bicyclists.

11. Adherence to these Criteria does not remove the Developer's responsibility to investigate and obtain any other regulatory permits or approvals, from either local, regional, state, or federal agencies, that may be required for a particular project.

12. Residential lots adjacent to a water transmission main shall be served by a separate local water main. Direct connection will not be allowed from any residential tap into a transmission main. Existing water taps on transmission mains shall remain.

13. Residential lots adjacent to a sewer interceptor or trunk main shall be served by a separate local sewer main. Direct connection will not be allowed for any residential use into an interceptor/trunk main. Existing sewer taps on interceptor/trunk mains shall remain.

14. All proposed projects shall be referenced to the Town of Windsor's adopted survey control network and shall obtain the location and elevation of the nearest appropriate reference monument from the Engineering Department prior to survey. The monument *name* and elevation used shall be clearly marked on all construction drawings.

B. DEFINITIONS AND ABBREVIATIONS

Wherever the following words, phrases, or abbreviations appear in these specifications they shall have the following definition and meaning.

1. AASHTO – American Association of State Highway and Transportation Officials.

2. AC – Acre.

3. AC-FT – Acre-feet.

4. ACI – American Concrete Institute.

5. ADA – Americans with Disabilities Act.

6. ANSI – American National Standards Institute.

7. APWA – American Public Works Association.

8. AS-BUILT DRAWINGS – Drawings reflecting actual conditions and information for the project after construction is completed.

9. ASME – American Society of Mechanical Engineers.

10. ASTM – American Society for Testing Materials.

11. AVERAGE DAILY DEMAND – The average of the total amount of water used each day during a one (1) year period.

12. AWWA – American Water Works Association.

13. BID – The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

14. BIDDER – The individual, firm, corporation, or other legal entity submitting a Bid directly to the Owner.

15. CAPTIAL EXPANSION FEE WATERLINES – If the Town requires a Developer to construct water over-sizing improvements, the Developer may be eligible for reimbursement from the Town for approved materials costs above that required for the development.

16. CDOT – Colorado Department of Transportation.

17. CDPHE – Colorado Department of Public Health and Environment.

18. CFS – Cubic feet per second.

19. CODE – The latest official adopted ordinances, policies, codes, resolutions, and/or regulations of the Town of Windsor, Colorado.

20. CONSTRUCTION DRAWINGS – Detailed and working drawings including plan, profile, and detail sheets of proposed utility, drainage and street improvements approved by the Town Engineer which graphically shows the scope, extent, and character of the Work to be performed by the Contractor.

21. CONSULTANT – The partnership, corporation, or individual who is registered as a professional engineer, according to Colorado statutes, and who is hired by the Developer/Owner, and is empowered to act as his agent for the project.

22. CONTRACTOR – The person, firm, or organization to whom a construction contract is awarded by the Developer, or Owner, or who has been issued a right-of-way work permit by the Town. Agents, employees, workers, or designers employed by the Contractor are also bound by the terms of the contract or permit.

23. DESIGN ENGINEER – The partnership, corporation, or individual who is registered as a professional engineer, according to Colorado statutes, and who is hired by the Developer/Owner, and is empowered to act as his agent for the project. The Design Engineer may also be referred to as the Professional Engineer, Consultant, Civil Engineer, Geotechnical Engineer, or Water System Engineer.

24. DESIGN FLOW – The appropriate water demand for the design of the water distribution system. Normally this would be the sum of the required fire flow for the most stringent situation plus the maximum daily demand or the peak hourly demand, whichever is greater.

25. DEVELOPER – The owner, corporation, association, partnership, or individual who, desiring to construct a public or private improvement within the Town's right-of-way or easements, having secured all required and necessary approvals and permits, has entered into an agreement with the Town and has entered into an agreement with the Contractor to perform the construction work.

26. DIP – Ductile Iron Pipe.

27. EASEMENT – The property right of the Town (or other specific entity) to use lands owned in fee by a private party for the purposes of utility installation, maintenance, access, drainage, or other use, as specified on a plat or deed of dedication.

28. EPA – Environmental Protection Agency.

29. EQUIPMENT – All machinery, tools, and apparatus together with supplies for upkeep and maintenance, necessary for the proper construction and acceptable completion of the Work.

30. FEMA – Federal Emergency Management Agency.

31. FINAL ACCEPTANCE – The written notification from the Town, that the Warranty Period has been satisfactorily completed, that all public improvements are free of defects and the Town releases the Developer from future maintenance obligations.

32. FIRE FLOW – Required fire flow is the rate of water flow, at a residual pressure of twenty (20 psi) pounds per square inch, for a specified duration that is necessary to control a major fire in a specific structure.

33. FT^2 – Square feet.

34. FPS – Feet per second.

35. GEOTECHNICAL ENGINEER – The partnership, corporation , or individual who is registered as a Professional Engineer or Professional Geologist, according to Colorado Statutes, and who is hired by the Developer/Owner to prepare the Soils Report and Final Pavement Design Report for the project.

36. GMA – Growth Management Area – The areas defined in the Town of Windsor's Master Plan as existing or future potential annexation areas.

37. GPCD – Gallons per capita per day.

38. GPD – Gallons per day.

39. GPM – Gallons per minute.

40. HP – Horsepower.

41. INSPECTOR – An authorized representative of the Town Engineer, assigned to make inspections to assure Work is completed in compliance with plans, standards and specifications.

42. LANDSCAPING – Materials including, without limitation, grass, ground cover, shrubs, vines, trees, and non-living materials, commonly used in landscape development, as well as attendant irrigation systems.

43. LIFT – The maximum specified thickness of material that may be placed at one time.

44. MAXIMUM DAILY DEMAND – The maximum total amount of water used during any twenty four (24) hour period in a three (3) year period. (This value should consider and exclude any unusual and excessive uses of water that would affect the calculation.)

45. MAY – A permissive condition. No requirement for design or application is intended.

46. MUTCD – Manual on Uniform Traffic Control Devices.

47. NEC – National Electric Code.

48. NEIGHBORHOOD – A residential or commercial area defined by ordinance, resolution or common understanding.

49. NFRWQPA – North Front Range Water Quality Planning Association (regional 208 agency).

50. NON-CAPITAL EXPANSION FEE WATERLINES – When the Town requires a Developer to construct waterline improvements through certain eligible areas, the Developer may be eligible for design and construction cost reimbursements from other developments that connect to that waterline improvement.

51. NON-POTABLE – Water that is not treated to approved drinking water standards and is not suitable or intended for human consumption, but is produced and delivered for irrigation use.

52. OFFICIAL – A person appointed by the Town to administer these Standards.

53. OPINION OF COST (COST ESTIMATE) – Unit costs, based on those approved by the Town and assigned to materials and related quantities. The Opinion of Cost shall be broken down by Phase, when applicable, for each project and shall be submitted by the Designer at the time of first plan review by the Town.

54. OSHA – Occupational Safety and Health Administration.

55. OVERSIZING AGREEMENT – An agreement between the installing Developer and the Town of Windsor for the purpose of reimbursing the installing Developer for oversizing of certain improvements in the project.

56. OWNER – The developer, corporation, association, partnership, or individual who has entered into an agreement with the Town and has entered into an agreement with the Contractor to perform the Work.

57. PEAK HOURLY DEMAND – The maximum amount of water used in any single hour, of any day, in a three (3) year period. It is normally expressed in gallons per day (gpd) by multiplying the actual peak hour use by twenty four (24).

58. PLANS – Detailed and working drawings including plan, profile, cross-sections, and detail sheets depicting proposed public utility improvements to be constructed for the project, approved by the

Town Engineer, which show the location, character, dimensions, and details of the Work to be done.

59. POTABLE WATER – Water free from impurities in amounts sufficient to cause disease or harmful physiological effects. The bacteriological, chemical and radiological quality shall conform to State Primary Drinking Water regulations.

60. PROFESSIONAL ENGINEER (P.E.) – An individual whom has been licensed as a professional engineer and has active status as determined by the Colorado Department of Regulatory Agencies, State Board of Registration for Professional Engineers and Surveyors.

61. PROFESSIONAL LAND SURVEYOR (P.L.S.) – An individual whom has been licensed as a professional land surveyor and has active status as determined by the Colorado Department of Regulatory Agencies, State Board of Registration for Professional Engineers and Surveyors.

62. PROJECT – The public or private improvement(s) designated in the approved plans, which are to be constructed in conformance with these Standards. The term "Project" includes any and all public or private improvement projects for or within the Town of Windsor, whether development projects, private utility projects, or capital improvement projects.

63. PROVIDE – Furnish and install complete in place.

64. PRV – Pressure Reducing Valve.

65. PSI – Pounds per square inch.

66. PUBLIC IMPROVEMENTS – Those public-type facilities to include: pavement, curb and gutter, sidewalk, pedestrian/bike/equestrian paths, storm drain facilities with related appurtenances, culverts, channels, bridges, water distribution or transmission facilities with related appurtenances, sanitary sewer collection facilities with related appurtenances, water and wastewater treatment facilities, pavement markings, signage and striping, traffic signals and related appurtenances, erosion control and right-of-way grading, or earth excavation processes integral to construction of other public improvements listed herein.

67. PUNCHLIST – A written list of work items, compiled by the Inspector, Engineer, Official, or other authorized individual, which do not conform to these Standards, the plans or other associated Town Codes that govern the project.

68. PVC – Polyvinyl Chloride (pipe).

69. P.V.I. – Point of intersection of the tangents of a vertical curve.

70. RCP – Reinforced Concrete Pipe.

71. RECORD DRAWINGS – Original design drawings updated and revised by a Professional Engineer depicting all modifications from the design that occurred during construction. (see As-Built Drawings).

72. REIMBURSEMENT AGREEMENT – An agreement between the installing Developer and the Town of Windsor for the purpose of reimbursing the installing Developer for the installation or oversizing of certain improvements in the project.

73. RIGHT-OF-WAY – All streets, highways, avenues, lanes, alleys, courts, places, squares, curbs, sidewalks, easements, or other public ways in the Town of Windsor which have been or may hereafter be dedicated and opened for public use, or such other public property so designated in any law of this state.

74. ROAD OR STREET – As used in this specification shall include the pavement section, right-of-way, sidewalks, driveways, bikeways, alleys, and alley approaches.

75. SDR – Standard Dimension Ratio (pipe outside diameter over minimum pipe wall thickness).

76. SHALL – A mandatory condition. Where certain requirements in the design or application are described with the "shall" stipulation, it is mandatory that these requirements be met.

77. SHOULD – An advisory condition. Where the word "should" is used, it is considered to be advisable usage, but not mandatory. Deviations may be allowed when reasons are given which show that the intent of the standard is met.

78. SHOULDER – The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of the base and surface courses.

79. SIDEWALK – Paved or otherwise improved area for pedestrian use, located within the public street right-of-way that also contain roadway for vehicular traffic.

80. SPECIFICATIONS – Construction specifications and standards adopted by the Town of Windsor.

81. STANDARD SPECIFICATIONS for ROAD AND BRIDGE CONSTRUCTION – CDOT's printed manual, 2005 Edition, for construction and material details.

82. STANDARD STREET SPECIFICATIONS – The current Town of Windsor Design Criteria and Construction Specifications for Streets.

83. STANDARD WATER DISTRIBUTION AND SANITARY SEWER COLLECTION SYSTEM SPECIFICATIONS – The current Town of Windsor Design Criteria and Construction Specifications for water lines and sewer lines and their appurtenances.

84. SUBCONTRACTOR – A person, firm, or organization, other than the Contractor, supplying labor and materials, or labor only, for the Project, and working for the Contractor or Developer or Town.

85. SUBSTANTIAL COMPLETION – The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of the Town Engineer, the Work (or a specified part thereof) is sufficiently complete so that the Work (or a specified part thereof) can be put to beneficial use and can be utilized for the purposes for which it was intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

86. TOWN – The Town of Windsor, Colorado, a Home Rule Municipality, or an individual employed by the Town of Windsor whom is authorized to make the applicable decisions on behalf of the Town.

87. TOWN ENGINEER – A term used in situations where a decision or action may be required by the Town Engineer or his authorized representative employed by the Town of Windsor. The Engineer shall have the authority on behalf of the Town to ascertain that all design and construction is equal to or exceeds the minimum requirements set forth in these criteria and standards.

88. TRAFFIC CONTROL PLAN (TCP) – Those portions of the Contract Documents and/or plans that contain the requirements and procedures for the maintenance of traffic during construction of the project.

89. UNCC – Utility Notification Center of Colorado. (1-800-922-1987).

90. USGS – United States Geological Survey.

91. UTILITIES – Shall mean all utilities on site prior to the time of any design; such as but not limited to water lines, sanitary sewer lines, drainage lines, electric lines, gas lines, telephone lines, and cable television lines.

92. WARRANTY PERIOD – The period of time that the Contractor/Owner or Developer is responsible for material and workmanship defects in the public improvements, until written notification by the Town of final acceptance of the public improvements.

93. WORK – All construction activity, including materials, labor, supervision, and use of tools and equipment necessary to complete the Project in full compliance with these Standards, approved Plans, or Improvement Agreements.

94. WQCD – Water Quality Control Division of CDPHE.

95. W-SFPD – Windsor-Severance Fire Protection District.

1.03 DEVELOPMENT PROCEDURES AND POLICIES

A. GENERAL

This section is intended to describe the development procedures and policies of the Town of Windsor as they pertain to planning, design, approval, and construction of water distribution systems and sanitary sewer collection systems for which approval by the Town is required.

The Town's water supply, storage, and distribution capacity must always be adequate to meet demands during peak days and peak hours. The water system must also be able to deliver adequate fire flows under peak demand conditions. The infrastructure that provides this service must be extremely reliable, so that the public health and safety is not threatened if any component of the system fails.

The Town's sewerage collection system and treatment capacity must always be adequate to meet peak demand conditions. The sewer system must also be able to adequately carry expected sewerage flows under peak demand conditions in addition to infiltration and inflow. The infrastructure that provides this service must be extremely reliable, so that the public health and safety is not threatened if any component of the system fails.

B. VARIANCES AND APPEALS PROCESSES

1. VARIANCES

Any design that does not conform to these Standards must be approved by the Town Engineer. Variances from these Standards will be considered on a case-by-case basis following a written request for a variance prepared by a Professional Engineer. If the special district, developer, contractor, or utility responsible to the Town for public improvements desires to design and construct such improvements in variance to criteria in these standards, such variance(s) shall be identified in a written attachment to the initial submittal of construction plans to the Town Engineer. Generally, the plans should show the design variance. Variances may be administered by either of the following two processes:

a. Variances requested as part of an application for approval of a preliminary plat only, shall be shown on the preliminary plat (or on the preliminary construction plans) and shall also be specifically substantiated and justified in a letter addressed to the Town Engineer.

b. Variances requested as part of the submittal for approval of final public improvements construction plans shall be shown in the plans and shall also be specifically substantiated and justified in a letter addressed to the Town Engineer.

The variance request(s) shall include the following:

a. Identifying Issue. Identification of the standard to be waived or varied and why the standard is unfeasible or is not in the public interest.

b. Proposed Alternate Design. Identification of the proposed alternate design or construction criteria.

c. Comparing to Standards. A thorough description of the variance request including impact on capital and maintenance requirements, costs, and how the new design compares to the standard.

d. Justification. The Design Engineer must determine and state that the variance will not be detrimental to the public health, safety and welfare, will not reduce design life of the improvement nor cause the Town additional maintenance costs. The proposed plan (as

varied) must advance the public purpose of the standard sought to be varied equally well or better than would compliance with such standard.

e. Approval or Denial of Variance. Based upon review of the plans and additional information submitted, and an analysis of the criteria set forth in this subsection, the Town Engineer may approve or deny the variance request. If the Town Engineer approves the variance request, the plans will continue to be reviewed and approved within the typical review process. If the Town Engineer denies the variance request, the developer shall subsequently submit revised plans in compliance with these Standards. The Town Engineer shall provide a written response outlining the basis for all approvals or denials of variance requests.

2. **APPEALS**

a. Appeal to the Town Manager. If a variance request is denied by the Town Engineer, the Developer may appeal the decision to the Town Manager. All appeals shall be processed through the Town Engineer. The Developer shall give written notice of appeal to the Town Manager within ten (10) days after denial by the Town Engineer. The Town Manager shall respond within fifteen (15) working days after receipt of the Developer's notice to appeal. If the Town Manager overturns the Town Engineer's decision, the Developer may then proceed with the requested variance(s) in the plans. If the Town Manager concurs with the Town Engineer's decision, the Developer shall bring the plans into compliance with these Standards, or appeal the Town Manager's decision to the Town Board.

b. Appeal to the Town Board. The Developer may appeal to the Town Board of Windsor within ten (10) days from receipt of denial from the Town Manager. The appeal shall be placed on the agenda for consideration by the Town Board in accordance with normal Town Board procedure, but no later than sixty (60) days following receipt of the written notice of appeal. The Town Board shall hold a public hearing on the appeal in accordance with Town Board procedure. All notices and appeals shall be in writing. Any such appeal shall constitute a "new hearing" on the variance request before the Town Board.

3. **GRANTED**

Any variances granted as specified herein, are on a site specific basis only and do not carry or grant any future acceptance, precedent, or variance.

C. WATERLINE AND SEWER LINE CONSTRUCTION AND OVER-SIZING POLICY

1. WATERLINE AND SEWER LINE CONSTRUCTION RESPONSIBILITY

The responsibility for the design, right-of-way acquisition, and construction of all new waterlines and sewer lines and the upgrading/replacement of existing waterlines and sewer lines necessary to provide adequate water supply and fire protection service and/or sanitary sewer collection service to, or within, a development rests exclusively with the Developer, except as outlined in **Section 1.03.C.3**, below. All water demand and sewage flow generated by a development must meet the level of service requirements adopted by the Town of Windsor. The following list outlines the improvements that are considered to be an integral part of waterline and/or sewer line construction:

a. Trenching and subgrade preparation or stabilization.
b. Water main installation, including backfill and compaction.
c. Installation of waterline appurtenances, including valves, PRV's, air vacuum valves, fire hydrant assemblies, etc.

d. All testing, flushing, disinfection, and cleaning.
e. Water rights equivalent to projected demand for the development.
f. Sewer main installation, including backfill and compaction.
g. Installation of sewer line appurtenances, including manholes, wyes, risers, lift stations, force mains, grease traps, etc.
h. All testing, televising, and cleaning.
i. Erosion control management systems as necessary during construction.

2. REQUIRED WATERLINE AND SEWER LINE IMPROVEMENTS

a. General. The Developer is responsible for all improvements required of their development. In some cases, a financial security in a form acceptable to the Town may be allowed in lieu of construction of all or part of an improvement.

b. On-Site Criteria. The Developer is responsible for all improvements internal to the site. Necessary right-of-way and easements must be dedicated to the Town of Windsor prior to or concurrent with approval of the development.

c. Off-Site Criteria. The Developer is responsible for the following improvements external to the site boundaries:

i. Waterlines Adjacent to the Development Boundaries. Where waterline upgrades are needed to comply with these Standards and Windsor's Water Master Plan, the Developer shall be responsible for the design and construction of water system improvements adjacent to the exterior boundary of the subject property. When such water system improvements are designed and constructed, they shall be extended along the entire boundary(s) of the property at the size, alignment, and location that has been established in the Water Master Plan or as indicated herein.

ii. Access to an Acceptable Water Distribution System. Any development which does not have direct access to an acceptable water distribution system within the Town's network will be required to improve certain off-site waterlines, as deemed necessary by the Town Engineer. An acceptable water distribution system is one which has the capacity and capability of supplying an adequate supply of water, at certain minimum pressure and flow requirements, to the development to meet the projected potable supply, irrigation, and fire flow demands.

iii. Redundant Supply. All developments shall have redundant sources of water supply. Redundant supply provides a combination of adequate fire flow, uninterrupted customer service, and acceptable water quality. Redundancy shall be achieved by making a minimum of two (2) separate and distinct connections to an approved water distribution system within the Town's network, to facilitate the circulation and movement of water throughout the network. The Town Engineer, depending on required flows and/or other constraints or system capacities in the area of the proposed Development Project Area, may require a greater number of connections. Additionally, within internal portions of the Development, other separate and additional redundant connections shall be required wherever possible.

iv. Sewer Lines Adjacent to the Development Boundaries. Where sewer line upgrades are needed to comply with these Standards and Windsor's Sewer Master Plan, the Developer shall be responsible for the design and construction of sewer system improvements adjacent to the exterior boundary of the subject property. When such sewer system improvements are designed and constructed, they shall be extended along the entire boundary(s) of the property at the size, alignment, and location that has been established in the Sewer Master Plan or as indicated herein.

v. Access to an Acceptable Sewer Collection System. Any development which does not have direct access to an acceptable sewer collection system within the Town's network will be required to improve certain off-site sewer lines, as deemed necessary by the Town Engineer. An acceptable sewer collection system is one

which has the capacity and capability to adequately convey the spent water supply of the development, and any upstream tributary areas, for peak flow periods to a satisfactory point of treatment and disposal.

d. Grant of Water Rights. All developments requesting water service from the Town's water system shall furnish water rights to the Town of Windsor, as detailed in Section 13-2-80 of the Windsor Municipal Code. The water requirements for all zoning districts shall be reviewed and determined by the Town Board as specific development plans are proposed. The basis of water requirements shall be the anticipated annual water usage of the development.

e. Off-Site Right-of-Way and Easements. Prior to approval of any development which requires acquisition and dedication of off-site right-of-way or easements, the Developer shall provide legal documentation demonstrating their ability to obtain such right-of-way or easements without any restrictions and at no cost to the Town. Prior to final approval of plat and construction plan documents, all off-site rights-of-way and easements must be dedicated and recorded with the County Clerk.

3. **EXCEPTIONS FOR OFF-SITE CONSTRUCTION RESPONSIBILITY**

A Developer may not be responsible for constructing the off-site waterline and/or sewer line improvements needed to serve that development if circumstances meet any of the following conditions:

a. Improvements are included in the most recent Town of Windsor Water System and/or Sanitary Sewer Collection System Capital Improvement Plan, the funds necessary for construction of the improvements have been appropriated, and the improvements are scheduled for construction by the Town within three (3) years from the time of the Town Board's approval of the final plat for the development; or

b. Improvements are included in a fully funded plan by another public agency, such as the Colorado Water Conservation Board, and are scheduled for construction within three (3) years from final plat approval; or

c. Improvements are included in a binding agreement with another developer or private party for which financial security acceptable to the Town that fully covers the costs of the improvements is held by the Town.

4. **WAIVER FROM WATERLINE AND/OR SEWER LINE CONSTRUCTION RESPONSIBILITY**

The obligation to design and construct any waterline and/or sewer line improvements may be waived for a development that has been determined to have an insignificant system demand on the Town's network, as determined by the Town Engineer.

D. REIMBURSEMENT POLICY

Developments may be eligible for reimbursement of certain costs for waterline and/or sewer line improvements made off-site and/or adjacent to the development if the requirements of the reimbursement policy for new waterline and sewer line construction are followed and will be considered on a case by case basis. Additionally, those improvements for which capital expansion fees (oversizing) are collected may also be eligible for credit or reimbursement, subject to the provisions in the Town Code.

1. **NON-CAPITAL EXPANSION FEE WATERLINES AND SEWER LINES**

a. General. When any Developer, as a Town required condition of development, designs and constructs waterline and/or sewer line improvements to serve property through undeveloped areas or areas that may be redeveloped, or is required to design and construct waterline and/or sewer line improvements along the perimeter of the property, the entire cost of such engineering and construction, including acquisition of all necessary rights-of-way, shall be the responsibility of such person or Developer. Such person or Developer, however, may be eligible for design and construction cost reimbursements from other developments that connect to those improvements. Conversely, if the Developer connects to a water system or sanitary sewer improvement constructed by another Developer or the Town, the Developer may be required to participate in the design and construction costs of those improvements.

b. Front Footage Charge. If the following conditions are satisfied, the installing Developer may enter into a reimbursement agreement with the Town such that, as a condition of approval of subsequent development or re-development of property adjacent to the newly constructed waterline or sewer line improvements, the Town may collect a front footage charge from the abutting Developer prior to the issuance of any building permits for the abutting property. The front footage charge shall be established by prorating the total amount of original certified costs to the lineal frontage of all properties abutting the constructed improvement.

c. Notice of Agreement. The Town shall not attempt to make such collection until the reimbursement agreement is properly prepared and executed and the owners of abutting property have received or reasonably should have received notice of the reimbursement agreement.

d. Letter of Intent. Within ninety (90) days of the completion and acceptance by the Town of such improvements, the Developer shall notify the Town in writing of its intent to enter into a proper reimbursement agreement with the Town.

e. Full Payment. All costs for the construction of improvements must be fully paid by the Developer before such person shall be entitled to reimbursement under any agreement established hereunder.

f. Documentation of Costs and Obligated Properties. After written acknowledgment by the Town of receipt of said written intent to enter into a reimbursement agreement, the Developer shall have sixty (60) days to provide the Town Engineer with copies of the following:

   i. A letter from the Designer with detailed breakdown of all fees that are directly attributable to the improvements eligible for reimbursement and a statement certifying that all such fees have been paid in full.
   ii. A letter from the Developer's Contractor with a detailed breakdown of costs for all improvements eligible for reimbursement and a statement certifying that all such costs have been paid in full.
   iii. A letter from the Developer's financing office certifying any financial charges assessed that are eligible for reimbursement.
   iv. An accurate map prepared by a licensed Engineer or Surveyor which shows:
      A. The location and limits of the eligible improvements;
      B. The name, address, and telephone number of the owner of each property abutting the eligible improvements;
      C. The frontage of each property (with lineal footage shown);
      D. The reimbursement amount due from each property based on the original certified costs, divided by the frontage of all abutting properties, multiplied by the frontage of the individual property;

E. The book, page, reception number, and name of County, from the records of the County Clerk and Recorder or the name of the recorded plat from which the information for each property was obtained; and

F. Any other information deemed necessary by the Town Engineer to properly prepare a reimbursement agreement.

g. Reimbursement Agreement Forms. After receipt of written notice from the Town Engineer documenting Certified Costs, the Developer shall provide three (3) signed original Reimbursement Agreement forms to the Town. Following execution of the agreement by the Town, two (2) signed originals shall be returned to the Developer, who shall record one of the agreements with the appropriate County Clerk and Recorder.

h. Notification of Agreement. After execution and recording of the reimbursement agreement, the installing Developer shall certify, by affidavit, that all owners of properties obligated to provide reimbursement have been notified in writing through certified mail with return receipt requested. The Town shall then cause to be published a public notice listing the properties and reimbursement amounts. The Town shall endeavor to provide notice on future plats of property obligated to provide reimbursement of the recorded agreement, but the failure to provide notice shall not relieve the owner of the platted property of any reimbursement obligation.

i. Inflation Adjustment. The amount of reimbursement assessed by the Town for each adjacent property as it develops shall be based on the certified costs of the improvements plus an adjustment for inflation based on the construction cost index for Denver, Colorado, as published monthly by "Engineering News Record". The Town Engineer's determination concerning total eligible costs shall be final.

j. Collection. The Town's obligation to reimburse the Developer shall be contingent upon the Town's actual collection of the front footage charge from the abutting developer. The Town shall have no obligation to reimburse any funds that it fails to collect, for whatever reason, provided that the Town made a good faith attempt to collect such funds.

k. Service Charge. When the front footage charge is collected, the Town shall reimburse the installing Developer to the extent of such collection after deducting a service charge of five hundred ($500.00) dollars or three (3%) percent of the amount collected, whichever is greater, to cover the Town's legal, engineering, and administrative costs.

l. Payment. Funds collected pursuant to a reimbursement agreement shall be paid to such person as identified in the agreement, and if such person cannot be found, to an alternate if designated in the agreement.

m. Limitations. Any right to reimbursement pursuant to this provision shall not exceed a period of ten (10) years from the acceptance by the Town of the waterline improvements. The Town Board may approve one (1) extension of the reimbursement agreement not to exceed an additional ten (10) years if application for extension is made prior to the expiration of the original. No such reimbursement shall be made unless the person entitled to reimbursement has fully satisfied their obligations under any other agreements with the Town.

2. **CAPITAL EXPANSION FEE WATERLINES AND SEWER LINES**

The Town may require a Developer to install waterline and/or sewer line improvements with main lines larger than is needed to adequately serve the proposed development. Upon prior budget

appropriation by the Town Board and approval by the Town Engineer, Developers of certain water system and sanitary sewer collection system improvements may be entitled to receive a reimbursement from the Town, against a portion of the amounts paid for public improvements installed and paid for by such Developer on specified arterial water mains designated in the Town's Water Master Plan and/or on specified sewer trunk mains designated in the Town's Sewer Master Plan. Payment of such reimbursement shall be subject to the following:

a. Required but Unnecessary Water Main and/or Sewer Line Over-Sizing Improvements. If the Town requires a Developer to construct over-sizing improvements that are not necessary to safely serve the development and these improvements are identified as part of the Water Master Plan or Sewer Master Plan, then the Town will reimburse the Developer for the approved materials costs above that required for the development, as soon as funds are available after completion and final acceptance of the improvements by the Town. The difference in materials costs shall only include the difference in pipe materials, valve materials, manhole sizes, service wyes, and fitting materials; all other items are considered incidental to the installation of the waterline and/or sewer line and shall not be reimbursed. If the Town is unable to reimburse the Developer because of insufficient funds in the waterline or sewer line reimbursement plan budget, the Developer will be paid interest at the same rate the Town is earning on its pooled investments during the reimbursement period beginning three (3) months after acceptance of the approved over-sizing improvements until reimbursement is completed.

b. Required and Necessary Water Main and/or Sewer Line Over-Sizing Improvements. If the over-sizing improvements are necessary to safely and adequately serve the development, as determined by the Town Engineer, and the improvements are part of the Town's Water Master Plan or Sewer Master Plan, the Town shall reimburse the Developer for approved materials costs or as predefined in a development agreement. Interest will not be paid on the reimbursement because the need for the improvements was dictated by the development.

The Developer shall submit a materials list with unit prices, quantities, and a cost comparison between the pipe sizes under considerations. Reimbursement will be paid only after the As-Built Record Drawings have been accepted by the Town. Copies of material invoices for materials delivered to the site and used in construction shall be provided along with the Developer's request for reimbursement.

E. MAINTENANCE OF PRIVATE IMPROVEMENTS

1. Compliance. When a request is made for the Town to assume maintenance of any private improvement, it shall be the responsibility of the person(s) making the request to satisfactorily demonstrate that the private improvement has been constructed in accordance with these Standards.

2. Review. The Town will review these requests under normal review procedures.

3. Refusal of Responsibility. The Town will not accept maintenance responsibilities for private waterline and sewer line improvements associated with land development activities. Private improvements that were not constructed in accordance with the applicable design and construction standards and specifications shall not be accepted for maintenance by the Town.

1.04 WATERLINE LAYOUT REQUIREMENTS

A. GENERAL

1. The purpose of this section is to provide the minimum criteria necessary for system analysis, layout, and design of a potable water distribution system.

2. This section is not intended to be inclusive of all situations and the design Engineer may be required to use additional engineering judgment to meet the overall design intent for constructability and long-term operations and maintenance.

3. All waterline design and layout for new developments shall conform to these Standards and the Town's Water Master Plan (WMP) and other applicable Comprehensive Master Plans, codes and standards adopted by the Town.

4. All waterlines and their appurtenances shall be installed in dedicated road rights-of-way, beneath the street surfaces. Waterlines to be installed in exclusive easements and rights-of-way may be approved when, as determined by the Town Engineer, it is not practical to make such installation in the dedicated street.

5. Waterlines shall not be installed beneath any concrete flatwork such as sidewalks, curb and gutter, and cross pans, except when the waterlines are crossing the concrete installation. All Portland Cement Concrete Pavements (PCCP) are an exception to this requirement.

6. Additionally, it is critically important within each development project area that the site layout be designed in a manner that accommodates acceptable access for future maintenance by the Town's Water Department.

7. In addition to the requirements of these Standards, each development project area shall have redundant sources of water supply. Redundant supply provides a combination of adequate fire flow, uninterrupted customer service and acceptable water quality. Redundancy is typically achieved by making at least two (2) separate and distinct connections to the existing Town's water distribution system. The Town, depending on required flows and/or other constraints or system capacities in the area of the proposed development, may require a greater number of connections. Additionally, within internal portions of the development, other separate and additional redundant connections shall be required wherever possible.

B. DESCRIPTION

The Town's Public Water System includes transmission mains, trans-distribution mains, distribution mains, and water services, including appurtenances. Other specific Public Water System components may include fire hydrants, in-line valves, blowoffs, pressure reduction valves (PRV's), booster pump stations, and storage facilities.

1. Transmission Mains. Potable water transmission mains are large diameter waterlines that primarily serve as a delivery conduit that moves water through the distribution system between the supply and storage points, between pressure zones, and between trans-distribution mains. Transmission mains are eighteen (18″) inches and larger. There shall be no individual service taps allowed on transmission mains; the Town Engineer must first approve any type of connection to a transmission main.

   Transmission mains should be arranged into several interlocking loops, typically not more than three thousand (3,000′) feet apart. Looping allows continuous service through the rest of the trans-distribution and distribution mains, even when one portion is shut down temporarily for repairs or maintenance. Under normal conditions, looping also allows supply from two (2) directions for

large fire flows. Transmission mains should be equipped with blowoff valves at low points and air-relief valves at high points.

2. Trans-distribution Mains. Trans-distribution mains are large diameter potable waterlines that move water between distribution mains and may have frequent distribution main connections. Trans-distribution mains carry large quantities of water from the transmission mains to points in the system in order to provide for normal supply and fire suppression. They form smaller loops within the loops of the transmission mains by running between transmission mains and distribution mains. Typically, tees and/or individual taps less than six (6″) inches shall not be allowed on trans-distribution mains. Potable water trans-distribution mains within the Town's system are typically ten (10″) inch, twelve (12″) inch, fourteen (14″) inch, and sixteen (16″) inch diameter.

   Trans-distribution mains should be spaced only a few blocks apart. This spacing allows concentration of large amounts of water for fire fighting without excessive head loss and resulting low pressure.

3. Distribution Mains. Distribution mains deliver potable water to individual customers and may be tapped along their length with individual service connections. Distribution mains normally have in-line valves placed frequently to lessen the impacts associated with shut downs, line breaks, and potential service interruptions. Potable water distribution mains within the Town's system are eight (8″) inch, ten (10″) inch, and twelve (12″) inch diameter.

   Distribution mains form a grid over the area to be served and are typically sized to provide domestic, fire protection, and irrigation flows to and throughout the development project area. The size of these mains will usually be determined by the design flow. Use of other systems such as reclaimed water (purple pipe) or irrigation ditches may reduce the need to deliver irrigation demand through the Town's water system; however, the Town must first approve such systems.

4. Water Services. Potable water services include all piping, fittings, meters, and appurtenances used to convey potable water from the distribution main to the customer.

5. Minimum Allowable Pipe Sizes. The minimum allowable pipe diameter for water mains in the Town's distribution system shall be eight (8″) inches. Along section lines, or close proximity, the minimum pipe diameter shall be twelve (12″) inches, and along quarter (¼) section lines, or close proximity, the minimum pipe diameter shall be ten (10″) inches. Hydrant leads connecting to the potable distribution system shall be six (6″) inches. Other pipe diameters for hydrant leads are prohibited.

   The Town's Water Master Plan sizing layout may override these general standards. The Town Engineer may also require oversizing of certain waterlines, beyond those identified in the Water Master Plan.

C. SYSTEM LAYOUT

The following design layout criteria for waterlines are required for all new construction, rehabilitation, and retrofit installations:

1. Horizontal Requirements.

   a. Location:

      i. Within platted rights-of-way and improved public streets, waterlines should generally be located ten (10′) feet north and west of street centerlines, where feasible, or symmetrically within a dedicated exclusive easement of appropriate width.

ii. In all cases, water valve placement shall not interfere with the vehicular tire traffic pattern.

iii. Waterlines shall not be installed beneath any concrete, such as sidewalks, curb and gutter, and cross pans, except when the waterline is crossing the concrete installation.

iv. A potable waterline serving one (1) lot shall extend all the way across the frontage for that lot.

b. Looping:

i. An adequate number of connections to the existing potable water distribution system shall be provided such that no more than twenty (20 sfr) single family residences, or the equivalent single family flow for non-residential developments, are out of service at any one time.

ii. Potable waterlines shall extend to the extremities of the property, project development area, or the subdivision served. Extensions shall be in appropriate locations to provide adequate water connections and to maintain looping requirements for adjacent, future developments and to facilitate the completion of the grid system.

iii. Potable waterlines shall be extended offsite when required to tie into the existing distribution system for additional water source connections. Appropriately sized easements shall be provided.

iv. In all instances, the Town shall determine the potable water system looping requirements for a project development area on a case by case basis and may require additional potable water connections over and above those demonstrated by a hydraulic analysis in order to maintain overall water system performance. Ultimately, the required source connections to the existing potable water system shall be solely determined by the Town.

c. Separation:

i. Wet utilities (*e.g.* public wastewater, public or private stormwater, public or private reclaimed water and any related appurtenance) running parallel to a public waterline and/or related appurtenance, shall be no closer than ten (10′) feet, measured from nearest outside edge of each pipe or related appurtenance.

ii. Dry utilities (*e.g.* natural gas, electric, cable TV, Telephone/Communications and any related appurtenance) running parallel to a public waterline and/or related appurtenance, shall be no closer than six (6′) feet, measured from nearest outside edge of each pipe or related appurtenance.

iii. Upon maturity, outside edges of any shrub or bush shall be no closer than five (5′) feet to the nearest outside edge of a public water system main and/or any related appurtenance. Upon maturity, the outside edge of any tree trunk shall not be closer than ten (10′) feet to the nearest outside edge of a public water system main and/or any related appurtenance.

iv. Berms greater than two (2′) feet high and/or with side slopes steeper than four to one (4:1), shall not be allowed within ten (10′) feet of a public water system main and/or any related appurtenance.

v. Parallel installation of other utilities in exclusive waterline easements is not permitted.

d. Curvilinear Alignments. Generally, all waterlines should be installed in straight lines as staked between specified or otherwise authorized angles, bends or points of tangency of horizontal or vertical curves. Depending on type of pipe material, waterlines proposed within curved portions of rights-of-way or easements may be designed utilizing either manufactured bends, pipe-joint deflections, or pipe bending, when specifically approved by the Town Engineer and meeting the following requirements:

i. Bends. Bends shall be Ductile Iron Pipe (DIP), mechanical joint (MJ) type and shall be restrained with approved restraint devices.

ii. Pipe Bending. Longitudinal, barrel portion pipe bending may be allowed with PVC pipes twelve (12″) inches in diameter or smaller, only upon review and approval of the Town Engineer and per manufacturer's recommendations. Minimum bending radius shall not be less than three hundred times (300 x OD) the pipe outside diameter. All joints shall be mechanical restrained joints (MEGALUG®), backfilled with at least thirty six (36″) inches of compacted trench backfill and bending shall be accomplished manually. PVC pipes larger than twelve (12″) inches in diameter may not use this method.

iii. Pipe Deflection:

A. Curvilinear pipe installation with DIP may be accommodated by pipe-joint deflection OR bend installation. When pipe-joint deflection is used, each pipe-joint deflection shall not exceed four (4°) degrees for pipes six to twelve (6″ - 12″) inches in diameter and shall not exceed two and a half (2½°) degrees for pipes sixteen to thirty (16″ - 30″) inches in diameter.

B. Curvilinear pipe installation with PVC pipe should typically be made using DIP bends; however, pipe-joint deflections may be used with prior approval of the Town Engineer. When pipe-joint deflection is used, each pipe-joint deflection shall not exceed two and a half (2½°) degrees for pipes six to eight (6″ - 8″) inches in diameter and shall not exceed one and a half (1½°) degrees for pipes ten to twelve (10″ - 12″) inches in diameter.

C. PVC pipe can also be joined with High Deflection (HD) Couplings which allow five (5°) degrees of pipe-joint deflection per coupling. HD couplings can be used in the place of small bends or where it is undesirable or impossible to deflect the pipe.

iv. Construction Plans. When pipe is deflected at each joint to accommodate either horizontal or vertical curvilinear alignments or to avoid obstructions, each curved alignment section shall be labeled with curve data and shown on the Plan & Profile Construction Plans. Data shall include PC and PT stations, radius, delta, length, joint deflection per joint and pipe segment lengths.

2. Vertical Requirements.

a. Depth of Bury:

i. Cover. Except at crossings or lowerings, normal bury depth for all waterlines shall be five (5′) feet minimum and six (6′) feet maximum, as measured from finished grade to top of pipe.

ii. Non-compliance. When design or constructability constraints are present, deeper or shallower waterline installation may be permitted only with approval from the Town. Additional design and installation considerations (such as frost protection) may be required, depending on the situation.

b. Vertical Separation:

i. Clearance. All potable waterlines, including water service lines, shall have a minimum eighteen (18″) inches vertical separation from all utilities, measured from outside diameter.

ii. Crossings. Where sanitary sewer lines cross beneath potable waterlines with less than the eighteen (18″) inches vertical separation, where sanitary sewer lines cross above potable waterlines, or where the ten (10′) foot horizontal clearance between potable waterlines and sanitary sewer lines cannot be

maintained, pipe encasement of the sanitary sewer shall be designed and constructed so as to protect the potable waterline.

iii. Centered. In all cases, the crossing pipes shall be centered over each other so that the joints are at a maximum distance from the crossing.

c. Alignment and Grade:

i. Bends. When utilizing manufactured bends, water mains shall be designed to maintain a uniform positive or negative grade between all bends (high and low points). All portions of uniform grade/pipe shall be denoted on the construction plans mathematically by percent or decimal of slope. All bends shall be denoted with a top-of-pipe, vertical datum elevation, and a horizontal reference station.

ii. Transmission Mains. Water transmission mains and all waterlines larger than twelve (12″) inches in diameter shall be designed and installed strictly to grade to allow proper installation of air relief and air vacuum valves and blow-off valves. All pipes shall be constructed to the lines, grades and elevations shown on the construction plans.

3. Crossings Requirements.

a. General. When a waterline crosses a sanitary or storm sewer, crosses another public or private utility, irrigation or drainage ditch, the crossing design and construction shall protect the main utility's structural integrity, prevent contamination of the waterline, and mitigate future system impacts and costs of repair. The agency responsible for the utility, ditch, railroad or other structure crossed by the waterline may also impose additional criteria. All crossing(s) shall be shown in plan and profile view, clearly identified and dimensioned on the construction plans.

b. Waterline Crossing Over a Sanitary/Storm Sewer Line. When a public waterline crosses these types of systems, the waterline should cross above, with a minimum of eighteen (18″) inches vertical separation from such system AND maintain the required bury depth. If there is less than eighteen (18″) inches vertical separation, the sewer line shall be encased with concrete for ten (10′) feet on each side of the crossing and the waterline shall be a twenty (20′) foot section of pipe centered on the crossing. The Town Engineer may also require encasement, joint wrap, or the use of solid steel casing pipe and casing seals; in some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe, from manhole to manhole.

c. Waterline Crossing a Dry Utility Line. When a public waterline crosses these types of systems, typically the waterline crosses below the dry utility, with a minimum of eighteen (18″) inches vertical separation from such system AND maintain the required bury depth of the waterline. If there is less than eighteen (18″) inches vertical separation, the dry utility shall be encased in high density polyethylene pipe (HDPE), Standard Dimension Ration eleven (SDR 11), from edge to edge of the easement or right-of-way, or ten (10′) feet on either side of the potable waterline, whichever is greater.

d. Sanitary/Storm Sewer Line Crossing Over a Waterline. When a public waterline crosses under these types of systems, encase the sewer line no matter what the vertical clearance is, for a distance of ten (10′) feet each side of the crossing. Where waterlines cross under storm sewers, the encasement of the storm sewer shall only be required at each joint (minimum of four (4′) feet encasement) along a twenty (20′) foot section, ten (10′) feet each side of the waterline. If the vertical separation on any waterline crossing is less than eighteen (18″) inches, the waterline shall be installed in a twenty (20′) foot

section of steel casing pipe, centered on the crossing. The proper corrosion protection is required where the steel casing pipe is utilized. In some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe, from manhole to manhole.

e. Waterline Crossing Over a Waterline. If there is less than eighteen (18″) inches vertical separation, the crossing design shall be reviewed and approved by the Town Engineer.

f. Waterline Crossing Under a Ditch. When a waterline crosses under a ditch, the Ditch or Irrigation Canal Company shall be contacted for approval of each crossing. In addition to these standards, the Ditch Company may modify or add to the requirements of these Standards, provided their requirements are more stringent.

   i. Casing Pipe. A casing pipe encompassing the potable waterline shall be installed beneath all ditches. Depending on the configuration of the ditch, the casing pipe shall extend a minimum of ten (10′) feet beyond any toe or top of slope of the ditch.
   ii. Material and Class of Pipe. The type of material and class of pipe to be utilized in these crossings will be as specified by the Town Engineer.
   iii. Cover. Potable waterline crossings under any open ditch shall have a minimum bury depth of five (5′) feet, measured from the flowline of the ditch to the top of the casing pipe.
   iv. Valves. The waterline/ditch crossing shall be isolated by valves near each end of the crossing/casing. These in-line valves shall be located such that the waterline at the crossing can be isolated with enough room to allow for maintenance; typically placed approximately forty (40′) feet from each end of the casing pipe.
   v. Cut-off Wall. Typically, a concrete cut-off wall shall be placed at both ends of the casing pipe; extending vertically to the maximum free surface water elevation of the ditch. In some cases, with the Ditch Company approval, a clay cut-off wall may be used instead of concrete.
   vi. Ditch Rehabilitation. All ditches shall be restored to original condition, according to the ditch company's material and construction criteria.

g. Encasements. All concrete encasements shall be installed per these specifications and the Town's Standard Details. Additional support may be required by the Town Engineer where large diameter lines cross. Encasement of joints on sewer lines shall be a minimum of six (6″) inches thick and extend a minimum of one (1′) foot on each side of any joints.

h. Right Angle Crossings. Crossings of waterlines shall be at right angles and meet the requirements given above. Parallel installation of other utilities in exclusive waterline easements is not permitted. Where this requirement may become burdensome, the Town Engineer may waive this requirement, on a case by case basis.

i. Bored Crossings. Bored utility crossings shall have a minimum twenty four (24″) inches of vertical clearance from the outside diameter of the utility casing to the outside diameter of the potable waterline if the bored utility crosses above the potable waterline and a minimum of thirty six (36″) inches of vertical clearance from the outside diameter of the utility casing to the outside diameter of the potable waterline if the bored utility crosses below the waterline.

j. Conflicts. If there are horizontal or vertical clearance conflicts between the potable waterline and a utility, the Town may require that the potable waterline be lowered, raised, or realigned in order to maintain the required clearances. For a waterline

crossing situation not specifically mentioned in this section, the crossing requirements provided herein shall be applied to that particular situation to the best extent possible.

4. Lowering Requirements.

   a. General. In cases where a waterline cannot meet the Crossing Requirements stated above, the main may be permitted to cross beneath a wet or dry utility by "lowering". All lowerings are subject to clearance and freeze protection requirements noted in these Standards. In addition to a plan view for each lowering, all such lowerings shall be specifically shown and designed in a "to-scale, engineered" profile view. Each profile view shall show horizontal stations for each bend, fitting, valve, casing end(s), and any deflections. Each profile view shall also show vertical distances and vertical elevations (to top of pipe), relative to the finish grade and to the utility(s) being crossed. Plan and Profile views shall show horizontal and vertical distances to other utilities or structures in the immediate area of the lowering.

   b. Bends. Fittings and bends (*e.g.* 11¼, 22½, 45 degree) constructed of ductile iron pipe (DIP) with mechanical joints (MJ) and approved restraint devices, is the preferred method of lowering for waterlines. See Standard Detail Drawings.

   c. Vertical Sweeps. In some cases, with prior approval of the Town Engineer, it may be preferable to vertically sweep a waterline beneath a wet or dry utility or structure. When a vertical sweep has been approved and is used, the following criteria shall be followed:

      i. Joint Deflection:
         A. Vertical sweep pipe installation with DIP may be accommodated by pipe-joint deflection OR bend installation. When pipe-joint deflection is used, each pipe-joint deflection shall not exceed four (4°) degrees for pipes six to twelve (6″ - 12″) inches in diameter and shall not exceed two and a half (2½°) degrees for pipes sixteen to thirty (16″ - 30″) inches in diameter.
         B. Vertical sweep pipe installation with PVC pipe (allowed only upon approval of the Town Engineer) should typically be made using DIP bends; however, pipe-joint deflections may be used with prior approval of the Town Engineer. When pipe-joint deflection is used, each pipe-joint deflection shall not exceed two and a half (2½°) degrees for pipes six to eight (6″ - 8″) inches in diameter and shall not exceed one and a half (1½°) degrees for pipes ten to twelve (10″ - 12″) inches in diameter.
         C. PVC pipe can also be joined with High Deflection (HD) Couplings which allow five (5°) degrees of pipe-joint deflection per coupling. HD couplings can be used in the place of small bends or where it is undesirable or impossible to deflect the pipe.

      ii. Construction Plans. When vertical sweeps are utilized and pipe is deflected at each joint to accommodate either horizontal or vertical curvilinear alignments or to avoid obstructions, each curved alignment section shall be labeled with curve data and shown on the Plan & Profile Construction Plans. Data shall include PC and PT stations, radius, delta, length, chord, joint deflection per joint and pipe segment lengths. Reverse curve data shall also be denoted.

5. Frost Protection Requirements.

   a. Cover. To protect from frost, normal bury depth for all waterlines shall be five (5′) feet, as measured from finished grade to top of pipe.

b. Open Conduits. Public waterlines should have at least five (5′) feet of clearance between open conduits (*e.g.* stormwater boxes, inlets, pipes, culverts, and ditches) and other open channels that are exposed to the atmosphere and free flow of air.

c. Protection. When required clearances cannot be obtained, all potable waterlines shall be insulated through the extents of the insufficient cover plus an additional twenty (20′) feet at each end. The insulating board shall be two (2″) inch thick foam insulation, meeting the minimum widths given in the following table:

Table 1.04.1
Foam Insulation Widths (Feet)

Clearance to Waterline (ft)	Pipe Diameter (inches)					
	6″	8″	10″	12″	16″	24″
0.67′*	4.2′	4.3′	4.5′	4.7′	5.0′	5.7′
1.5′*	3.5′	3.7′	3.8′	4.0′	4.4′	5.0′
2′	2.5′	2.7′	2.8′	3.0′	3.3′	4.0′
3′	1.5′	1.7′	1.8′	2.0′	2.3′	3.0′
4′	0.8′	0.9′	1.2′	1.5′	2.0′	2.5′

* Use double thickness insulation for these shallow depths.

6. Dead-end Waterlines.

a. Maximum Length. The maximum length and size of a permanent dead-end waterline shall be determined relative to the number of service lines and fire protection needs; however, in no instance shall a permanent dead-end potable waterline exceed three hundred (300′) feet. Temporary waterlines for future extensions and waterlines in Cul-de-sacs shall not be required to meet this maximum length specification.

b. Fire Hydrants. All dead-end waterlines shall terminate with a fire hydrant assembly placed on the end of the line.

c. Waterlines in Cul-de-sacs. Potable waterlines serving a cul-de-sac shall be extended to within ten (10′) feet of the lip of street gutter at the end of the cul-de-sac and shall have a fire hydrant assembly placed on the end of the line.

d. Conflicts. In cases where a waterline cannot meet these criteria, the waterline shall be designed to create a looped/redundant system with appropriate connections to an alternate portion of the Town's existing or proposed water distribution system.

D. PHASED INSTALLATION

1. If potable water distribution system phasing is proposed within a development project area, the phasing shall be clearly identified on the master utility plan. Construction Drawings, including plan and profile sheets, shall clearly show and label the phasing transitions in the potable waterline design.

2. All proposed potable water system phasing shall maintain looping integrity within the system as described elsewhere in these criteria.

3. The phased potable water system design shall meet the phased water demands for the development and adhere to all potable water system and hydraulic design requirements provided in these criteria.

4. Locate line valves and temporary fire hydrants at the end of each phase or stub-out. The stub-out shall be shown on the potable water plans.

5. Phased waterline or stub-out construction shall be extended a minimum of ten (10′) feet beyond phased street paving to avoid asphalt removal during excavation for future connections.

6. Phased potable waterlines or stub-outs intended for future connections shall be valved such that only one (1) valve needs to be closed when the main is extended and no customers are without water service when the line is extended. The valve must be appropriately restrained so that it will not “blow off” when the water line is exposed and all thrust blocking is removed for the extension.

7. The maximum length of a stub-out shall not exceed one hundred fifty (150′) feet unless otherwise approved by the Town Engineer.

8. Potable waterline stub-outs that are not utilized shall be abandoned at the connection to the main waterline, as directed by the Town Engineer.

1.05 WATERLINE APPURTENANCES

A. VALVES

1. General:

    a. Gate valves shall be used on waterlines up to and including twelve (12″) inch diameter.

    b. Butterfly valves shall be used on waterlines fourteen (14″) inch diameter and larger.

    c. Valves, including butterfly valves, shall be direct bury. Gate valves shall be installed with a screw type, adjustable valve box, unless otherwise required by the Town Engineer. Butterfly valves shall be installed in manholes or vaults.

2. Location and Placement:

    a. All valves shall be located in a dedicated street right-of-way or within a dedicated exclusive easement of appropriate width. Approval by the Town Engineer is required for all other valve locations.

    b. Residential potable water distribution systems shall have valves placed in such a manner so as to ensure that no single accident, break, or repair necessitates shutting down a length of pipe greater than six hundred (600′) feet or more than one (1) residential block may be out of service.

    c. Valves should be located at not more than five hundred (500′) foot intervals in commercial districts.

    d. Valve placement on trans-distribution mains shall be no further than twelve hundred (1200′) feet apart.

    e. Valve placement on transmission mains, typically shall be no further than one thousand three hundred twenty (1320′) feet apart.

    f. Valve placement shall be such that there are two (2) valves at every tee and three (3) valves at every cross. Valves shall be placed a maximum of five (5′) feet from a tee and/or a cross, except for roundabouts.

    g. For valves required mid-block, where possible, they shall be located at the extension of property lines.

    h. When waterlines are designed in such a way that a dead-end exists at the edge of a subdivision or at the boundary of a filing/phase within a subdivision, the waterline shall be terminated with an isolation valve restrained back to the fitting, two (2) full lengths of restrained pipe, and a temporary fire hydrant.

    i. When a new waterline extension connects to an existing waterline not terminated with a valve, the new waterline must have valves at the connection point in order that the entire, newly constructed system may be pressure tested and disinfected.

    j. Valves shall be placed on both sides of all encased crossings unless another valve is within one hundred fifty (150′) feet of the proposed crossing valve and only if no water services will be placed out of service.

k. Potable waterlines serving a cul-de-sac shall be extended to within ten (10′) feet of the lip of street gutter at the end of the cul-de-sac and shall have a fire hydrant assembly placed on the end of the line. The valve for the fire hydrant assembly shall be either eight or six (8″ or 6″) inch in size and shall be located no closer than five (5′) feet from the lip of street gutter.

l. Fire hydrant and fire sprinkler line gate valves shall be placed at the main. These gate valves shall be mechanical joint (MJ) valves and fasten to a mechanical joint (MJ) anchor tee (swivel tee) on the main.

m. Valves and valve boxes shall not be located within any portion of a concrete area such as sidewalks, cross pans, aprons, or curb and gutters and, unless specifically waived by the Town Engineer and shall meet the following setbacks:

   i. No closer than five (5′) feet to the lip of any concrete cross pan.
   ii. No closer than eight (8′) feet to the lip of the street gutter without prior approval by the Town Engineer.
   iii. In all cases, valve and valve box placement shall not interfere with the vehicular tire traffic pattern.

n. Valves should not be located within the center island of a roundabout and, if possible, out of the roadways of a roundabout.

o. All potable waterline valves shall have a concrete collar around the valve boxes in accordance with the Standard Detail Drawings and these specifications. The recommended method of concrete collar is to saw cut pavement edges a minimum of one (1′) foot out from the valve box, at least eight (8″) inches deep. Fill with concrete to a depth of six (6″) inches and then complete the final two (2″) inches with asphalt.

3. Air Release, Air/Vacuum, and Combination Air Valves:

a. Water transmission mains and all waterlines larger than twelve (12″) inches in diameter shall be designed and installed strictly to grade to allow proper installation of air release valves (ARV) and air vacuum valves (AVV). All pipes shall be constructed to the lines, grades and elevations shown on the construction plans. The Town Engineer shall have final determination on valve size, placement, and type of valve to install.

b. These valves shall perform the following operations:

   i. ARV's release accumulated air from a pipeline during filling operations and while the system operates under pressure exceeding atmospheric pressure.
   ii. AVV's release air automatically during pipeline filling and admit air automatically when the internal pressure in the pipeline drops below atmospheric pressure.
   iii. Combination Air Valves (CAV's) perform the same functions as an ARV and an AVV.

c. Air release valves (ARV's) shall be provided at all high points. ARV's placement and design shall meet AWWA M51 design criteria, shall be properly sized by the Design Engineer in accordance with the manufacturer's recommendation, and shall be placed in manholes or vaults.

   i. Automatic ARV's shall not be used in situations where flooding of the manhole or chamber may occur.
   ii. The open end of an air relief pipe from automatic valves shall be extended to at least one (1′) foot above grade and provided with a twenty four (24) mesh non-

corrodible screened, downward-facing elbow. The pipe from a manually operated valve should be extended to the top of the pit.

iii. Chambers, pits, vaults, or manholes containing valves, blowoffs, meters, or other such appurtenances to a water distribution system, shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground.

d. Air vacuum valves (AVV's) shall generally be placed at severe low points, lowerings, and/or at crossings. The Town Engineer will assist the Design Engineer in determining sizes and placement of AVV's.

4. Pressure Regulating Valves:

a. Pressure regulating valves (PRV's) are used to control water pressures between potable water distribution system pressure zones. PRV's shall be of a type capable of maintaining pre-adjusted downstream pressures with varying rates of flow and upstream pressure without causing water hammer.

b. When waterline extension plans are submitted for review, the need for a PRV installation will be determined based on existing pressure zones and the existing distribution system. The final decision for the need for a PRV and its installation location shall be determined by the Town Engineer.

c. PRV (valves) shall be sized so that the velocity through the valve at maximum demand does not exceed twenty five (25 fps) feet per second. If a wide range of flow rates is anticipated, more than one valve may be required. Care shall be taken to ensure adequate pressure differential across the valve under all ranges of flow to accomplish hydraulic throttling.

d. When pressure differentials greater than forty five (45 psi) pounds per square inch are expected, or when the downstream pressure will be low relative to the differential, special valve materials or a special valve design may be required.

e. Plans shall be submitted indicating size, type, and proposed location for the PRV installation. All calculations, drawings with all fittings shown, and shop drawings for the valve and vault must be submitted and approved by the Town Engineer prior to construction.

B. FIRE HYDRANTS AND FIRE PROTECTION

1. General:

a. All fire protection, fire flow, and hydrant requirements are subject to approval by the Windsor-Severance Fire Protection District (W-SFPD).

b. All fire hydrant leads shall have a minimum of five (5′) feet of cover from top of pipe to finish grade elevation.

c. No permanent structure or obstruction shall be allowed within ten (10′) feet of the nearest edge of a fire hydrant. Shrubs and bushes (upon maturity) cannot be within five (5′) feet, and tree trunks (upon maturity) cannot be within ten (10′) feet of the nearest edge of a fire hydrant. No concrete surfaces shall be closer than one (1′) foot to a fire hydrant.

d. A frangible, traffic breakaway feature shall be incorporated into the barrel of each fire hydrant and shall be six to ten (6″ - 10″) inches off the ground.

e. The operating nut shall be one and five sixteenths (1 5/16″) inch pentagon, opening counterclockwise (CCW).

f. The exposed portion of the fire hydrant shall be painted red.

2. Location:

a. All fire hydrants shall be located in a dedicated street right-of-way or within a dedicated exclusive easement of appropriate width. Approval by the Town Engineer is required for all other fire hydrant locations.

b. Waterlines not designed to carry fire-flows should not have fire hydrants connected to them. Hydrants designed to carry fire-flows shall conform to the National Fire Protection Association standards.

c. Spacing. The criteria noted herein are general guidelines and may be changed or varied due to use of sprinklers or other factors as determined by the Town Engineer, or the Windsor-Severance Fire Protection District (W-SFPD). For the following spacing requirements, fire access distance is the distance a fire pumper must travel to lay a standard hose line from a fire hydrant to the primary access point of a structure. The hose lay distance is not measured over unimproved areas that may be impassable due to weather conditions, obstructions, etc. Fire protection and fire hydrant spacing shall meet the following:

i. Single-family and two-family residential developments shall have fire hydrants placed no more than five hundred (500′) feet apart and no portion of a structure shall be further than three hundred (300′) feet, fire access distance, from a fire hydrant.
ii. Multi-family and attached single-family residential developments shall have fire hydrants placed no more than four hundred (400′) feet apart and no portion of a structure shall be further than two hundred (200′) feet, fire access distance, from a fire hydrant. Multiple fire hydrants may be required by the W-SFPD.
iii. Commercial, Mixed-use and Industrial developments shall have fire hydrants placed no more than three hundred (300′) feet apart and no portion of a structure shall be further than one hundred fifty (150′) feet, fire access distance, from a fire hydrant. Multiple fire hydrants may be required by the Windsor-Severance Fire Protection District (W-SFPD).
iv. Where new waterlines are extended along/within streets where fire hydrants are not required for protection of adjacent structures, fire hydrants shall be provided at a spacing not to exceed one thousand (1,000′) feet. When the roadway is divided by a median, fire hydrants must be placed on alternate sides of the roadway every five hundred (500′) feet.

d. Locations. Generally, fire hydrants shall be located at intersections whenever possible. Hydrants located mid-block shall be placed between lots at the property line. Fire hydrants shall be located within the right-of-way or easement and on the same side of the street as the water main unless otherwise specified by the fire department. No part of the fire hydrant assembly shall protrude over the edge of the sidewalk. Minimum distance from driveways shall be five (5′) feet.

e. Cul-de-sacs. Fire hydrants shall be located at the entrance of all cul-de-sacs. A fire hydrant shall be located at the terminus of the waterline at the end of the cul-de-sac, but may not be counted by the W-SFPD for fulfillment of required hydrants.

3. Placement:

a. Fire hydrant branch lines shall be a minimum of six (6″) inches in diameter and shall be set at ninety (90°) degrees to the street mains. No horizontal bends or offsets shall be used in installing fire hydrant branch lines. Under no circumstances shall a service tap be made on a fire hydrant branch line.

b. All fire hydrant branch lines shall have six (6″) inch mechanical joint connections complete with a six (6″) inch gate valve with a swivel tee or a hydrant tee on the main waterline in order that the hydrant may be removed from the system for maintenance without affecting the distribution system. The branch line between the hydrant and valve shall be at least three (3′) feet long and the valve shall be installed with a valve box.

c. Valve opening size shall be five and one quarter (5¼″) inches, compression type; valve shall open by turning counterclockwise (CCW).

d. Fire hydrants shall be three-way; two (2) hose (two and one half (2½″) inch) brass nozzles and one (1) pumper (four and one half (4½″) inch) nozzle. All threads shall be National Standard Thread. Nozzle covers shall have the same size and shape nut as the operating nut. The fire hydrant shall be set at the end of the branch line and the pumper nozzle shall face the branch line or roadway.

e. Fire hydrants shall be of sufficient length so that the top of the fire hydrant shall be approximately three (3′) feet above the ground or curb grade and not less than eighteen (18″) inches from the finish grade to the center of the hose connection.

f. Fire hydrants shall be set to proper elevation and set vertically plumb and be properly braced to insure against movement during backfilling operations.

g. All fire hydrants must be self-draining and the valve and stem must be capable of being withdrawn through the barrel. Fire hydrant drainage shall meet the following requirements:

   i. Fire hydrant drainage in pervious soils shall be provided at the base of the fire hydrant by placing coarse gravel or crushed stone (¾″ to 1″) from the bottom of the trench to at least six (6″) inches above the waste opening in the fire hydrant and to a distance of one (1′) foot around the elbow.
   ii. Fire hydrant drainage in clay or other impervious soils shall be provided at the base of the fire hydrant by a drainage pit two (2′) feet in diameter and three (3′) feet deep excavated below the fire hydrant and filled compactly with coarse gravel or crushed stone (¾″ to 1″) under and around the elbow of the fire hydrant and to a level of at least six (6″) inches above the waste opening.
   iii. All fire hydrant drains shall be placed around the shoe and drain of all fire hydrants and covered with two (2) layers of approved plastic (8 mil thick) to keep the voids between the stone open. A minimum of two (2 oz/sy) ounce per square yard filter fabric shall be placed around the sides and bottom of the rock drain.
   iv. Fire hydrant drains shall not be connected to or located within ten (10′) feet of sanitary sewers or storm drains.
   v. Leave drain plug in place in high groundwater conditions and note on Construction “As-Built” Drawings.

h. All joints on the branch line from the main waterline to the fire hydrant shall be restrained per approved methods.

4. <u>Fire Sprinkler Lines</u>:

a. All fire sprinkler lines are subject to approval by the Town Engineer and the Windsor-Severance Fire Protection District (W-SFPD).

b. Fire sprinkler lines shall have separate, dedicated taps off the Town's water system main line. Fire sprinkler lines shall not be tapped off any portion of a domestic service line. Additionally, fire sprinkler lines shall not be tapped off any portion of a fire hydrant branch line. All fire sprinkler lines shall be located a minimum of five (5′) feet from any domestic service line.

c. Fire sprinkler lines shall not be installed in trenches with other conduits/utilities.

d. Fire sprinkler lines for a given property must be tapped on the main potable waterline within the confines of the property lines extended.

e. No potable water service taps shall be made on fire sprinkler lines.

f. Fire sprinkler lines must be connected to the potable water distribution system. Connections to non-potable irrigation systems are prohibited.

g. Fire sprinkler lines three (3″) inches or smaller shall be type "K" copper. Fire sprinkler lines larger than three (3″) inches shall be restrained DIP. Restrained DIP fire sprinkler lines require concrete thrust blocking at the main and a gate valve at the main. Sizes for fire sprinkler lines shall be approved by the Town Engineer and the W-SFPD.

h. Fire sprinkler lines are not required to be metered; however, they shall have a backflow preventer and a detector check.

i. All fire sprinkler lines shall be considered privately owned and maintained, from the connection of the service line into the valve, continuing on to a building structure.

j. Fire sprinkler line gate valves shall be placed at the main. Unless otherwise required by the Town Engineer, these gate valves shall be mechanical joint (MJ) valves and fasten to a mechanical joint (MJ) anchor tee (swivel tee) on the main and shall be installed with a screw type, adjustable valve box with cap stamped "FIRE".

C. THRUST BLOCKS AND PIPE RESTRAINT DEVICES

1. General. All fittings (*e.g.* bends, reducers, tees, crosses, plugs/caps, fire hydrant boots, valves, etc.) shall be mechanical joint; each fitting joint shall also be thrust blocked, where approved, or restrained with approved restraint devices; (*i.e.* MEGALUG® or approved equal).

2. Thrust Blocks.

   a. Thrust blocks shall be constructed at all bends and fittings which result in unbalanced line thrust.

   b. The design engineer shall determine the required size and dimensions of thrust blocks to use and they shall be shown on the Construction Drawings. Design engineer shall include necessary geotechnical information on soil bearing pressures in the calculations. Minimum design waterline pressure for thrust block design shall be two hundred (200 psi) pounds per square inch. See Town of Windsor Standard Details for table on minimum thrust block sizes.

   c. During construction of thrust blocks, care shall be taken not to block outlets or to cover bolts, nuts, clamps, or other fittings or to make them inaccessible. A bond breaker shall

be placed between the fitting and the thrust block to aid in ease of future removal or repair.

d. The vertical sides of the concrete thrust blocks shall be formed to allow for symmetrical thrust. All concrete thrust blocks shall be designed for shape and size as required by type of soil and shall in every instance bear against undisturbed earth.

   i. If soil bearing strength is unknown, soil bearing capacities used in design must be approved by the Town Engineer.
   ii. When it is impossible, through over-excavation or other causes, to place a thrust block against undisturbed earth, mechanical joint restraints shall be required to anchor the fittings to the main, with the approval of the Town Engineer.

e. Backfill may be placed over the thrust block once the surface has set sufficiently to resist the weight of the backfill; however, no tamping or compacting shall be allowed above the thrust block for a minimum of twenty four (24 hr) hours after placement.

f. Concrete for thrust blocks must set a minimum of forty eight (48 hr) hours prior to the performance of a hydrostatic test on the water system.

3. Pipe Restraint.

a. If for any reason (*i.e*. temporary dead-end line, all fire hydrants and cul-de-sacs), concrete thrust blocks cannot be used, restrained push-on or mechanical joint restraints (a minimum of one pipe joint in length) shall be required.

b. The design engineer shall determine the length of required pipe restraint, for the pipe material being used, PVC or DIP, in accordance with AWWA M41 *Ductile-Iron Pipe and Fittings* or AWWA M23 *PVC Pipe – Design and Installation*, latest revision.

   i. Restraint calculations shall be submitted to the Town Engineer for review and approval.
   ii. Restrained length(s) shall be indicated on the Construction Drawings.

c. Unless approved otherwise by the Town Engineer, waterline pipe sizes twelve (12″) inches and less in diameter shall utilize the following restraint scenarios:

   i. When the distance between any combination of fittings is greater than one full/un-cut standard laying length of PVC or DIP pipe, a minimum of one full/un-cut standard laying length of pipe shall be mechanically restrained at each fitting and the fittings shall be restrained with a MEGALUG® restraint harness or approved equal, back from each fitting.
   ii. When the distance between any combination of fittings is less than one full/un-cut standard laying length of PVC or DIP pipe, each fitting shall be mechanically restrained as indicated herein with no pipe joint between.

d. For waterline pipe sizes larger than twelve (12″) inches in diameter, the design engineer shall specify the type of fitting joint, pursuant to these Standards, and in certain cases, may also be required to provide thrust/restraint calculations to determine if other and/or alternate thrust/restraint systems are necessary.

e. For all waterline pipe sizes, pipe joints through lowerings, crossings and within a casing pipe shall be restrained with mechanical joint devices.

D. ENCASEMENTS AND BORINGS

1. Concrete encasements shall be installed where called for on the Construction Drawings, where required by these Specifications, or where directed by the Town Engineer. Encasement requirements shall ultimately be determined by the Town on a case by case basis.

2. All encasement(s) shall be shown in plan and profile view, clearly identified and dimensioned on the construction plans. The encasement design and construction shall protect the main utility's structural integrity, prevent contamination of the waterline, and mitigate future system impacts and costs of repair.

3. Where sanitary/storm sewer lines cross beneath potable waterlines with less than eighteen (18″) inches vertical clearance, sanitary/storm sewer lines cross above potable waterlines, or the ten (10′) feet horizontal clearance between potable waterlines and sanitary/storm sewer lines cannot be maintained, sewer pipeline encasement shall be designed and constructed so as to protect the potable waterline.

4. Where non-potable irrigation lines cross above or below potable waterlines with less than eighteen (18″) inches clearance, the non-potable pipeline encasement shall be designed and constructed so as to protect the potable waterline

5. Where potable waterlines cross beneath sewer lines greater than thirty six (36″) inches I.D., the waterline shall be encased in a steel casing pipe extending ten (10′) feet on each side of the O.D. of the sewer line.

6. Concrete pipe encasement shall be placed on the sanitary/storm sewer line or non-potable irrigation line except in situations where the sanitary/storm sewer line or non-potable irrigation line is existing. Where the sanitary/storm sewer line or non-potable irrigation line is already constructed, at the option of the Town Engineer, steel pipe encasement shall be placed on the potable waterline.

7. The sewer line shall be encased with concrete for ten (10′) feet on each side of the crossing and the waterline shall be a twenty (20′) foot section centered on the crossing. The proper corrosion protection is required whenever DIP is utilized. Longer encasements may be required depending on the encasement situation. The Town Engineer may also require encasement, joint wrap, or the use of solid steel casing pipe and casing seals. In some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe that extends from manhole to manhole.

8. Encasements shall be a minimum of six (6″) inches thick and extend a minimum of one (1′) foot on each side of any joints. All concrete encasements shall be installed per these specifications and the Town's Standard Details. Additional support may be required by the Town Engineer where large diameter lines cross. Minimum reinforcement shall be one of the following:

    a. Number five (#5) rebar, continuous, placed at each corner of the encasement section tied with number three (#3) rebar at three (3′) foot centers.

    b. Six by six (6x6) – W4 x W4 welded wire mesh with eight (8″) inch minimum lap, tied every twelve (12″) inches.

9. Provide suitable backfill or other structural protection to preclude settling or failure of the higher pipe.

10. Where a potable waterline crosses over another potable waterline, if there is less than eighteen (18″) inches vertical separation, both waterlines must be twenty (20′) feet in length, centered over the crossing.

11. Installation of potable waterlines may require a bored casing pipe to facilitate main installation. Borings shall be installed where called for on the Construction Drawings, where required when crossing another agency's right-of-way or easement, where required by these Specifications, or where directed by the Town Engineer. Boring requirements shall ultimately be determined by the Town on a case by case basis.

12. The type of bored casing material, its bore length, carrier pipe material and the various properties shall be determined by the Design Engineer and shall be approved by the Town Engineer. Cathodic protection of steel casing pipes shall be included in all design evaluations.

13. If a bored casing for a waterline crosses another utility line, the crossing should have a minimum twenty four (24″) inches of vertical clearance from the outside diameter of the casing pipe to the outside diameter of the utility line if the bored casing crosses above the utility and a minimum thirty six (36″) inches of vertical clearance from the outside diameter of the casing pipe to the outside diameter of the utility line if the bored casing crosses below the utility.

14. If there are horizontal or vertical clearance conflicts between the potable waterline and a utility, the Town may require that the potable waterline or the utility line be lowered, raised, or realigned in order to maintain the required clearances. For a waterline crossing situation not specifically mentioned in this section, the crossing requirements provided in these Criteria shall be applied to that particular situation to the best extent possible.

E. CORROSION PROTECTION

1. All cast and ductile iron pipe, fittings, valves, and valve boxes shall be protected as specified in this section.

2. Polyethylene encasement shall be applied to all cast iron or ductile iron pipes, fittings, valves, valve boxes, and other appurtenances. The encasement shall be in tube or sheet form sized for each pipe diameter, eight (8) mils thickness, with a two (2″) inch wide, ten (10) mils thick, polyethylene pressure sensitive tape to close seams or hold overlaps.

3. All polyethylene tubing, tape, and installation shall conform to AWWA C-105, latest designation, specifications.

4. The polyethylene encasement shall prevent contact between the pipe or fitting and surrounding backfill and bedding material, but is not intended to be airtight or watertight. All rips, punctures or other damage shall be repaired with adhesive tape or with a short length of new encasement wrapped around the damaged area secured in the same manner as overlaps. Overlaps shall be a minimum of one (1′) foot at the end of each section and shall be secured by use of the polyethylene pressure sensitive tape, plastic string, or other material capable of holding the encasement in place until backfilling operations are completed.

5. Prior to installing the polyethylene encasement, clumps of mud or other contaminants shall be brushed off the pipe or fitting surface. Polyethylene tubes shall be installed in accordance with ANSI A21.5 Method A. Method A requires tubes to be overlapped one (1′) foot and secured with tape, and the slack width to be taken up on top of the pipe and taped at the quarter points.

F. CATHODIC PROTECTION

1. A certified Geotechnical Engineer must perform a soil resistivity survey of the construction area or a soil-test evaluation in strict accordance with AWWA C105, Appendix A. The results of the evaluation along with all survey data and calculations, together with the service history of other existing pipe in the area shall be submitted to the Town for consideration and review.

2. The Water-Saturated Soil Box method shall be used to measure the resistivity of the soil. Alternative methods may be used only upon approval of the Town Engineer.

3. The distance between sample locations shall be at the discretion of the Town Engineer.

4. If the soil-test evaluation concludes the soil is corrosive to DIP, metallic fittings, or steel casing pipe, the Design Engineer must submit to the Town for approval a comprehensive plan with proposed design for cathodic protection. The design shall be in accordance with the National Association of Corrosion Engineers (NACE) RP0169 latest revision.

G. WATER SERVICES AND METERS

1. Potable water service lines shall not be installed in trenches with other conduits/utilities. Potable water service lines shall be separated from other conduits a minimum of ten (10′) feet horizontally and eighteen (18″) inches vertically.

2. All potable water service lines shall be buried at least fifty four (54″) inches below the established grade of the street or ground.

3. A potable water service line for a given lot must be tapped on the potable water main within the confines of the property lines extended.

4. The water main to be tapped must extend along the entire length of the front lot line of the property to be served.

5. No potable water service taps shall be made on a fire sprinkler line.

6. <u>Potable Water Service Line Materials</u>:

    a. Service lines shall not be constructed with galvanized pipe or plastic pipe.

    b. Type “K” copper shall be used for potable water service lines three quarter (¾″) inch through three (3″) inch diameter.

    c. Ductile Iron Pipe (DIP) shall be used for all potable water service lines larger than three (3″) inches in diameter unless otherwise specified by the Town Engineer.

7. A separate potable water service line and meter must serve each structure.

8. No potable water service lines shall cross property lines, including irrigation systems, unless otherwise excepted by the Town for irrigating multiple outlots. Irrigation systems from a single potable water service shall only be allowed for use on that single property.

9. No compound potable water taps are allowed.

10. Pressure boosters are prohibited without adequate backflow protection.

11. Where feasible, potable water service lines shall be located at the center of the lot served, and typically are ten (10′) feet upstream of the sanitary sewer service. Sewer and water service lines must be a minimum of ten (10′) feet apart horizontally, or concrete encasement or special protection of the sewer line will be required.

12. That portion of the potable water service line between the main and the curb stop and/or meter when installed must be in a continuous straight line, with no joints and perpendicular, if possible, to the main line. Service lines stubbed into the property line shall be of sufficient length to allow direct connection to the shut-off valve.

13. Potable water service lines for lots at the end of a cul-de-sac street shall be tapped on the water main a maximum of twenty five (25′) feet from the curb line or the proposed curb line at the end of the cul-de-sac. The service line between the main and the property line in cul-de-sacs shall be in a continuous straight line. No service line may be constructed through or in front of any adjoining property.

14. No underground joints are allowed in the copper service pipe three (3″) inches or less in diameter between the corporation cock and the curb stop and/or meter. The use of underground joints may be allowed only on the repair of existing service lines with specific approval from the Town Engineer.

15. During the placement of concrete for curb and gutter, potable water service line locations shall be marked with a "W" on the face of the curb directly above the service location.

16. Under no condition is a potable water service line to be located under driveways, trees, or other permanent structures. Certain lots (such as in cul-de-sacs) may have the potable water service line located anywhere along the frontage but shall be a minimum of five (5′) feet inside the property being served.

17. Potable water service taps shall be separated by at least two (2′) feet, measured along the potable water main length, including when taps are on opposite sides of the potable water main. Potable water service taps shall also be a minimum two (2′) feet from all joints, fittings, or valves. No more than four (4) service taps shall be permitted on any one joint of pipe. Potable water service taps within four (4′) feet cannot be in the same pipe quadrant.

18. The corporation stop, curb stop, meter, that portion of the service line between the corporation stop and the meter, and five (5′) feet past the meter shall all be the same diameter.

19. <u>Service Connection</u>:

    a. All water service saddles shall be cast bronze with double silicone bronze straps and shall be from a manufacturer pre-approved by the Town.

    b. Corporation stops shall be AWWA taper thread to copper compression fittings and shall only be from a manufacturer pre-approved by the Town.

    c. All taps shall be inspected by the Town when water is on and trench opened.

20. <u>Curb Stops</u>:

    a. A curb stop or valve of the same size as the water service pipe and conforming to the following standards shall be installed on every service line between the water main and the meter, at plus or minus one (± 1′) foot from the right-of-way line or easement boundary.

    b. Curb stops shall be compression fittings, Minneapolis pattern, and shall only be from a manufacturer pre-approved by the Town, with an extension rod per manufacturer's recommendations.

    c. The curb stop box shall be installed exactly center over the curb stop valve and in a vertical position. The top lid of the curb stop box shall be installed a maximum of one (1″) inch above the final grade.

21. Potable water service meter pits/vaults shall be located as close as possible beyond the curb stop.

22. Potable water service meter pits/vaults shall be located after the curb stop in a landscaped area. Meter pits/vaults shall not be installed in any street, parking area, driveway, or sidewalk unless otherwise approved by the Town. Meter pit/vault shall be rated for HS-20 traffic loadings unless otherwise permitted by the Town. Curb stops in paved areas shall be in a street valve box.

23. There shall be no major landscaping (trees, boulders, or shrubs with mature growth greater than three (3′) feet), retaining walls, drainage facilities, utility vaults, service poles, buildings, or other permanent structures within ten (10′) feet of the meter pit/vault or curb stop.

24. Not withstanding the applicable provisions of the Town's Municipal Code, Chapter 13, Article II, Water, and/or as modified with the written approval of the Town Engineer, the following service types shall apply:

    a. Residential, Single Family, Duplex or Two-unit Townhome. A type of dwelling unit whereby each unit is situated upon its own separate, platted lot, shall be serviced by one (1), three quarter (¾″) inch tap, service line, curb stop or valve of the same size as the water service pipe, and meter (including meter pit) for each platted lot. The maximum number of allowable living units that can be serviced by this tap size is two (2) single family living units with a separate meter and shut-off for each unit.

    b. Residential, Multi-Family. A type of dwelling unit containing three or more residences whereby each residence is not situated upon its own separate, platted lot, shall be serviced by one (1) tap, service line, curb stop or valve of the same size as the water service pipe, and meter (including meter pit or vault) for each Multi-Family dwelling unit (*e.g.* master meter) and shall meet the following tap sizing requirements as a minimum:

        i. One (1″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is five (5) single family living units.
        ii. One and one half (1½″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is twelve (12) single family living units.
        iii. Two (2″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is thirty (30) single family living units.
        iv. Three (3″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is fifty (50) single family living units.
        v. Four (4″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is one hundred (100) single family living units.
        vi. Six (6″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is one hundred seventy five (175) single family living units.
        vii. Eight (8″) inch tap size: The maximum number of allowable living units that can be serviced by this tap size is three hundred (300) single family living units.
        viii. Larger required tap sizes shall be evaluated on a case by case basis and shall be approved by the Town Engineer.

    c. Commercial (Individual). A building with one (1) or more internal tenant spaces whereby each tenant space is situated on its own separate, platted lot, shall be serviced individually by one (1) tap, service line, curb stop or valve of the same size as the water service pipe, and meter (including meter pit or vault) for each platted lot. The Design Engineer shall submit calculations indicating required tap size for each unit which shall be reviewed and approved by the Town Engineer.

    d. Commercial (Tenant). A building with one (1) or more internal tenant spaces whereby each tenant space is not situated upon its own separate, platted lot, may be serviced by one (1) or more tap(s), service line(s), curb stop(s) or valve(s) of the same size as the water service pipe(s), and meter(s) (including meter pit or vault) for each building and/or

tenant space. The Design Engineer shall submit calculations indicating required tap size for each service(s) which shall be reviewed and approved by the Town Engineer.

e. Industrial. A building with one (1) or more internal tenant spaces whereby each tenant space is not situated upon its own separate, platted lot, may be serviced by one (1) or more tap(s), service line(s), curb stop(s) or valve(s) of the same size as the water service pipe(s), and meter(s) (including meter pit or vault) for each building and/or tenant space. The Design Engineer shall submit calculations indicating required tap size for each service(s) which shall be reviewed and approved by the Town Engineer.

f. Commercial/Industrial Irrigation. All commercial/industrial developments shall have a separate meter with approved backflow device for irrigation purposes, unless approved otherwise by the Town Engineer.

25. Proposed Developments shall extend future water service taps from the main to the curb stop prior to construction of street improvements. For proposed Residential development, water service taps shall be three quarter (¾″) inch type "K" copper. Proposed Commercial and Industrial developments should also provide for future potable water service taps, however, if the proposed use is unknown, the minimum allowable service size shall be a one (1″) inch type "K" copper service.

H. TAPPING THE MAIN

1. Connections to the existing potable water distribution system may be made by wet tap or cut in tee. All wet taps and cut-in tees shall be made by the Contractor under the direct supervision of the Town.

2. It shall be the Contractor's responsibility to provide all tapping materials (tapping sleeves, tapping valves, insulator kit, etc.).

3. For direct wet taps on existing transmission and trans-distribution mains or sixteen (16″) inch diameter trans-distribution mains, manufacturer's shop drawings and specifications for the proposed tapping sleeve shall be submitted to the Town for review and acceptance prior to installation of the tapping sleeve by the Contractor.

4. Direct wet taps on existing transmission mains or sixteen (16″) inch diameter trans-distribution mains shall require the installation of an insulator kit between the tapping sleeve and tapping valve.

I. BACKFLOW PREVENTION AND CROSS CONNECTIONS

1. To prevent possible backflow contamination of the Town's potable water system, a backflow prevention assembly shall be installed where backflow or back-siphon from a private water user's system might create a situation with higher pressure downstream (on the customer's side) of the water meter than exists in the main line.

2. The backflow prevention assembly shall be installed downstream of the water meter, either above ground, or inside a building with adequate drainage. No pit or vault installations will be approved without a sump pump and alarm system and as approved by the Town Engineer.

3. Backflow prevention installations are mandatory on buildings such as schools, commercial buildings, car washes, industrial operations, packing plants, chemical plants, or any business or property that uses water for the base mixture of any type of chemical, whether said chemical is classified toxic or nontoxic in nature.

4. Backflow prevention assemblies, which must be approved by the Town Engineer or Director of Public Works, shall be in conformance with the Colorado Cross Connection Control Manual, latest edition.

5. All backflow prevention assemblies shall be reviewed and accepted by the Town of Windsor prior to installation. All submittals should include the product information sheets for each apparatus, the type of installation (horizontal or vertical), and the intended use of the device. Testing of the device shall be performed by a certified tester.

6. Potable water service lines on any property or inside any building shall have NO physical connection with any pipes, pumps, hydrants, or tanks or non-potable irrigation systems that could draw or discharge any unsafe water or other contaminating materials into the potable water distribution system.

7. Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply.

8. Individual home booster pumps shall not be permitted or required for any individual water service from the Town's waterlines. The installation of pumps on service pipes is prohibited, except when specifically authorized in writing by the Town Engineer.

9. Lawn sprinkler systems must be tapped on the outlet (downstream) side of the meter pit in a separate pit. Approved testable vacuum breakers or other means of cross-connection control are required with each sprinkler system and shall be installed in a pit or vault.

10. All devices utilized for cross-connection control must meet the minimum requirements of AWWA, the Uniform Plumbing Code, latest edition of the Colorado Cross-Connection Control Manual, the Colorado Department of Public Health and Environment/Water Quality Control Commission, as well as the approval of the Town Engineer.

11. Separate, individual fire sprinkler lines that are not metered, shall have installed an appropriate detector check assembly on the system.

J. WATER LOADING STATIONS

Water dispensing units present special problems when the fill line may be used for filling both potable water vessels and other tanks or potentially contaminated vessels. To prevent contamination of the public water supply, the following criteria shall be met:

1. Air Gap. At all times an air gap, at least twice the diameter of the fill line, shall be maintained to prevent a submerged discharge line.

2. Hose Length. The fill hose and cross connection control device must be constructed so that when hanging freely it will terminate at least two (2′) feet above the ground surface.

3. Fill-line Terminus. The discharge end of the fill line must be unthreaded and constructed to prevent the attachment of additional hose, piping or other appurtenances.

1.06 POTABLE WATERLINE DESIGN

A. GENERAL

1. The purpose of this section is to provide information for the design and layout of a potable water distribution system. Potable water distribution system design shall be in accordance with the Town of Windsor Water Master Plan, latest revision, and these criteria.

2. This section is not intended to be inclusive of all situations and the Design Engineer may be required to use additional engineering judgment to meet the overall design intent for constructability and long-term operations and maintenance. This design criteria typically applies to potable water mains sixteen (16″) inches in diameter and smaller. The Town Engineer reserves the right to make final determinations of the system design based on the best interest of the Town's system.

3. This section specifies the minimum standards necessary for system analysis, layout, and design of Public Water Systems based on dynamic analysis using an appropriate hydraulic model and proposed demands. All waterlines should be sized after a hydraulic analysis based on projected flow demands and pressure requirements utilizing a flow network model incorporating any one of the several acceptable flow network analysis methods.

4. The goal of the design of a water distribution system is to provide for the peak-hour demands while maintaining a minimum acceptable pressure and not exceeding maximum velocities in pipes. Water main sizing is critical to ensure that pressures don't drop below standards during periods of high demands. Additionally, the water distribution system typically should be capable of supplying the average demand on the maximum-day plus the needed fire flows.

B. DESIGN CRITERIA

1. The maximum recommended static pressure for direct service is one hundred (100 psi) pounds per square inch. The Town of Windsor's standards are to provide a minimum of fifty five (55 psi) pounds per square inch under max day conditions, and a minimum of fifty (50 psi) pounds per square inch under peak hour conditions.

2. An appropriate design flow for potable water system design is normally the sum of the required fire flow for the most stringent situation plus whichever is greater, the maximum daily demand or the maximum hourly demand.

3. Fire Flow. Fire flow demand shall be determined in accordance with the State Insurance Services Office (ISO) guidelines. According to the Windsor-Severance Fire Protection District (W-SFPD), fire flow requirements for residential areas are a minimum of one thousand (1,000 gpm) gallons per minute for a two (2 hr) hour duration at twenty (20) psi. The fire flow requirements for commercial areas are a minimum of one thousand five hundred (1,500 gpm) gallons per minute for a two (2 hr) hour duration; however, fire flow requirements in commercial areas could easily reach three to four thousand (3,000 – 4,000 gpm) gallons per minute for a three (3 hr) hour duration. A complete system analysis shall be submitted for any fire demand in excess of 1,500 gpm.

4. Design Flow. The water demand criteria presented in the following tables are minimum criteria and the Town reserves the right to modify the criteria, at any time, for the design of specific projects. Potable water demand criteria for uses not provided in these tables shall be determined during system design.

Table 1.06.1
Residential Water Demands (gpm)

ZONE	Units per Acre	Max. Day Demand	Peak Hour Demand
E-1	1	0.7 gpm/ac	1.9 gpm/ac
SF-1	6-7	5.0 gpm/ac	13 gpm/ac
SF-2	7-9	6.0 gpm/ac	17 gpm/ac
MF-1	16-18	11 gpm/ac	32 gpm/ac
MF-2	29-31	20 gpm/ac	57 gpm/ac

Table 1.06.2
Commercial Water Demands (gpm)
(Per 1,000 ft^2 of building area)

COMMERCIAL USE	Avg. Day Demand	Max. Day Demand	Peak Hour Demand
Office building or small business	0.14 gpm	0.21 gpm	0.60 gpm
Restaurant	0.35 gpm	0.53 gpm	1.50 gpm
Supermarket or Dep't Store	0.14 gpm	0.21 gpm	0.60 gpm
Laundry, Dry Cleaning	0.70 gpm	1.10 gpm	2.90 gpm
Service Station (no car wash)	0.02 gpm	0.04 gpm	0.08 gpm
Car Wash	1.32 gpm	2.00 gpm	5.50 gpm
Hotel or Motel	0.24 gpm	0.36 gpm	1.00 gpm
Warehouse (non-industrial)	0.07 gpm	0.11 gpm	0.30 gpm

a. All water demands used in the design of potable water distribution systems are subject to approval by the Town.

b. Irrigation water is included in the residential water demand given in the table above, but not included in the commercial water demand. Irrigation demands for commercial uses shall be determined using a peak hour demand rate of twenty four (24 gpm/ac) gallons per minute per acre and the commercial development's estimated irrigated acreage.

c. Potable water demands have not been provided for industrial uses. Due to the extreme variation in water consumption amongst the different types of industry, industrial water demands shall be determined during system design when the industrial use is known or use assumed flows based on engineering analysis.

d. Design flow should be based on the fire flow requirement plus whichever is greater, the peak hourly demand or the peak daily demand.

5. Pressure Requirements. Potable water distribution systems must be designed to provide minimum and maximum system pressures as discussed previously. Water system pressure information for the Town's existing system may be obtained from the Town.

a. The system shall be designed to maintain a minimum pressure of twenty (20 psi) pounds per square inch at ground level at all points in the distribution system under all conditions of flow.

b. Twenty (20 psi) pounds per square inch residual pressure is required at any one (1) hydrant with peak hour and fire flow demands.

c. Pressure zones shall conform to existing Town of Windsor pressure zones as provided in the Water Master Plan, latest revision. Specific information on the pressure zones or to confirm which pressure zone a development or site is actually located in, may be obtained from the Town.

d. Pressure regulating valves (PRV) will be required between pressure zones. The PRV location shall be determined by the Town Engineer.

6. Hydraulic Design.

a. Friction Coefficient. Potable distribution mains shall be designed using a Hazen-Williams coefficient "C" equal to one hundred twenty (120).

b. Velocity. All pipes shall be sized for a maximum water velocity of no greater than ten (10 fps) feet per second at peak hour demand plus fire flow.

c. Head Loss. Head loss in pipes twelve (12") in diameter or less, at peak hour demand plus fire flow, shall not exceed ten (10′) feet of head loss per one thousand (1,000′) linear feet of pipe (10 ft/1,000 ft). For sixteen (16") inch diameter pipes and larger, head loss at peak hour demand plus fire flow shall not exceed three (3′) feet of head loss per one thousand (1,000′) feet of pipe (3 ft/1,000 ft).

7. Engineering Judgment. Good engineering judgment must be exercised in the design of potable water distribution systems; for example, if a manufacturing facility that uses large amounts of water for only eight (8 hr) hours during one shift per day, five (5) days a week with relatively little domestic or other use, the maximum hourly demand would be far in excess of what one would normally anticipate, given the average or maximum daily demand. In this case, the system should be designed to provide the required flow plus the maximum hourly flow; it would be foolish and irresponsible to consider treating a fire at this facility on the basis of an average daily demand that has no real meaning in this particular context.

   Available fire flows modeled under max day conditions are a strong indicator of system performance. Another indicator of system performance is the water velocities in pipelines under max day conditions.

C. HYDRAULIC ANALYSIS REPORT

A hydraulic analysis for the potable water distribution system for a given project shall be submitted by the Design Engineer, as a report, to the Town Engineer for review and acceptance. The hydraulic analysis report will be reviewed by the Town, along with the engineering construction drawings.

The objective of the hydraulic analysis report is to assist the Design Engineer with designing a project's potable water distribution system to adequately serve peak demands while adhering to the design requirements set forth in these criteria. The hydraulic analysis report for the potable water distribution system serves as a tool for demonstrating the necessary number of connection points to the existing system for adequate waterline looping, system reliability, and required pipe sizing.

Non-potable irrigation system hydraulic and design reports are also required for projects utilizing non-potable water for irrigation purposes.

The written hydraulic analysis report shall, at a minimum, include the following information:

1. Title Page

a. Report Title.

b. Project name and location.

c. Name, address, and phone number of:

i. Owner
ii. Developer
iii. Design Engineer that prepared the report.

d. Report preparation date.

2. Engineer Certification Sheet

a. The report shall be prepared by or under the direct supervision of a Professional Engineer, licensed to practice in the State of Colorado, possessing adequate experience in the design of potable water distribution systems.

b. The report shall contain a certification sheet indicating that the design was prepared under the direct supervision of the licensed engineer and shall contain his/her signature and registration stamp with date of certification.

3. Table of Contents

4. Project Description and Location

a. Clearly state the location of the project with text identifying the location, nature of the proposed development and identification of proposed supply/connection points to the Town's existing water distribution system. Provide a site vicinity map specifying the project's geographical location and the project area in acres.

b. The report shall clearly state the land use zoning, estimated number of residential lots or living units, commercial and/or industrial square footages, and the irrigated acreages.

c. Indicate if the project will be phased. Elaborate on the anticipated timing for each project phase and the phase's associated building and infrastructure construction.

d. For multifamily, commercial, or industrial developments, indicate if potable or non-potable water will be used for landscape irrigation. Discuss and identify any alternate water sources and or delivery systems for irrigation water.

e. Identify the locations of all potable water and non-potable irrigation connection points to the existing systems.

f. Discuss and identify existing potable and non-potable water lines and provide the pipe diameter, pipe material, and year of installation and operating pressures.

5. Water Utility Plan

a. Provide an overall Water Utility Plan drawing with a general overview of the entire project including, but not limited to, streets (complete with names), alleys, lot and block numbers, all proposed and existing utilities on and within one hundred (100′) feet of the project site, all existing and proposed easements and rights-of-way on and adjacent to the project site, and proposed and existing potable water and irrigation water supply systems.

b. The entire project shall be shown on one (1) sheet unless the project is too large to show in sufficient detail. If the Water Utility Plan must be shown on more than one (1) sheet, provide a key map on each sheet to aid in drawing orientation and locating the sheet construction in relation to the overall project.

c. The Water Utility Plan drawing shall include, at a minimum, the following information:

i. Map Scale, North Arrow, Vicinity Map.

ii. Proposed and existing Easements and Rights-of-way.

iii. Proposed and existing water system layout; mains and appurtenances with sizes, flows, node pressures and demands (minimum and maximum).

iv. Proposed point(s) of connection for potable water and non-potable irrigation mains to the existing system(s). All existing potable and non-potable waterlines shall be labeled with the pipe diameter, type of material, and year of installation.

v. Pressure zone(s) and topographic contours at two (2′) foot intervals, minimum.

vi. Underlying land uses, zoning, and densities.

vii. Proposed project phasing for utilities and structures.

viii. Other existing and proposed utilities that might affect the proposed water system layout or performance.

ix. Any other information deemed necessary by the Design Engineer or the Town Engineer.

6. References and Appendices

a. Provide a separate page referencing all design criteria, resources, and modeling software used in preparing the hydraulic study and report.

b. Provide appendices as necessary to include modeling result printouts, copies of demand assumption data, and fire flow test results.

c. Fire hydrant flow test results may be available from the Town of Windsor Public Works/Water Departments and/or the Windsor-Severance Fire Protection District (W-SFPD). All fire flow test pressures will be evaluated for use by the Town on a case by case basis.

7. Requirements and Assumptions

a. All equations used, water demand assumptions, irrigation needs calculations, and essential design requirements, parameters, and constraints utilized in the design of the potable water distribution system shall be shown concisely.

b. Indicate the software package(s) and version used for the water system modeling.

c. Indicate in which Town of Windsor potable water pressure zone(s) the project is located. Discuss and identify needs for any special improvements, *e.g.* PRV's, zone breaks, transmission mains, or tans-distribution mains, etc.

d. Document all calculations for estimated population, design flows, irrigated acreage, irrigation application rates, peaking factors, and any other necessary design calculations.

e. Provide hydrant fire flow and fire sprinkler flow requirements. Include calculations for fire flow demands for specific commercial/industrial sites, utilizing the State Insurance Services Office (ISO) guidelines.

f. Show design flow calculations and determination of which condition (peak hourly or max daily demand plus fire flow) governs.

g. Discuss any deviation from these standards and criteria and provide justification for any proposed variances. All such variances must be approved by the Town Engineer prior to approval of the development.

8. Potable Water System Analysis and Modeling

a. Requirements/Definitions of Flows:

i. Domestic Water Use. The peak hourly and/or max daily demand for domestic water use shall refer to all household and corresponding lot irrigation for single family and applicable multifamily residential potable water use. It shall also refer to all potable water use, including potable irrigation, for commercial and industrial uses.

ii. Fire Flow. Fire flow shall be inclusive of fire hydrant and fire sprinkler flow. Residential, commercial, or industrial developments requiring fire sprinkler systems shall have fire sprinkler demands, in addition to hydrant fire flows, placed in the hydraulic water model at appropriate node locations.

iii. Design Flow. The design flow shall be based on the fire flow requirement plus whichever is greater, the peak hourly demand or the max daily demand.

b. Modeling Scenarios:

i. Static. The static scenario shall establish the available water pressure for the project site with no demands on the system and serves to check that pressure requirements are maintained.

ii. Design Flow with Fire Flow. This scenario shall include the design flow, which is based on the fire flow requirement plus whichever is greater, the peak hourly demand or the max daily demand.

iii. Design Flow and Fire Flow with one (1) Water Connection Closed. While using the determined potable water demands for the design flow as indicated above, each connection to the existing potable water system shall be closed, in turn, and modeled. Fire flow shall be placed at a hydrant nearest to the closed connection. This scenario represents a worst-case water demand condition and shall only serve to demonstrate how the potable water distribution system within the development functions during this condition. It may be acceptable to not have the potable water system pressure and velocity requirements satisfied in this scenario only.

iv. Phasing. Water modeling shall be required for the incomplete potable water system as indicated per the planned phasing on the Construction Drawings, in order to demonstrate that the design flow with fire flow can be met for the interim phased condition.

The hydraulic report shall verify that a proposed potable water system can provide the required water demands for a given development, at an acceptable pressure, and meet the overall potable water system design requirements set forth in these Standards. Upsizing water mains within a development as a means to increase water system capacity in lieu of making a connection to another water source, is not permitted.

If the hydraulic water model demonstrates that a larger main is required to serve the phased condition than would be needed for the full build-out condition, the Owner/Developer is required to install the larger pipe at his expense and is not eligible for pipe oversizing reimbursement from the Town when the larger pipe is no longer needed.

v. Additional Scenarios. The Town may require additional scenarios, adjustments to the fire flow placement, reservoir elevations, and existing system connections, revision to the pipe and node schematic layout, and other model modifications as necessary to verify that the proposed potable water system will meet the design requirements and potable water demands of the development and the Town as a whole. At the Town's discretion, the existing or future potable water system beyond the limits of the proposed development may require modeling as part of the hydraulic analysis.

c. Modeling Procedure:

i. Hydraulic Grade Elevation. Connections to the existing Town's potable water distribution system are typically denoted as reservoirs with the same hydraulic grade elevation. The Town shall provide inflow pressure.

ii. Node Locations. The design engineer shall place estimated domestic water, fire sprinkler, and irrigation tap demands at appropriate node locations within the model as they relate within the project.

iii. Hydrant Locations. Locate fire flow demands at hydrant locations according to the modeling scenarios in the section above. The maximum allowable fire flow provided from any one (1) hydrant shall be one thousand five hundred (1,500 gpm) gallons per minute. If the required fire flow is in excess of one thousand five hundred (1,500 gpm) gallons per minute, the next closest hydrant shall be used until the required fire flow is met.

iv. Outflow Demands. Depending on the location of the development, existing potable water system performance and reliability in the area, number of available potable water connections, and surrounding land uses, some of the project's proposed potable water connections may require modeling as a demand point or no connection instead of a water source. The Town shall provide additional outflow demands for a development on a case by case basis.

9. Report Results

a. Provide a schematic layout of the potable water distribution system showing and labeling the reservoir connections, pipe network, and demand nodes as presented and analyzed for each water model scenario.

b. Design parameters and the critical conditions shall be shown on an overall plan of the study area. Under separate cover, the conditions shall be shown which isolates the critical condition.

c. Provide a Reservoir Report for the static condition. The Reservoir Report shall include the following information:

   i. Reservoir Identification Label

   ii. Elevation (ft)

d. Provide Pipe Reports for all modeled scenarios. Pipe Reports shall include the following information:

   i. Title of Scenario Modeled

   ii. Pipe Identification Label

   iii. Pipe Length (ft)

   iv. Pipe Diameter (in)

   v. Pipe Material

   vi. Hazen-Williams Coefficient

   vii. Pipe Control Status (open or closed)

   viii. Pipe Velocity (fps)

   ix. Upstream Calculated Pressure (psi)

   x. Head loss per thousand feet (ft/1,000 ft)

e. Provide Junction/Node Demand Reports for all modeled scenarios. Junction/Node Demand Reports shall include the following information:

   i. Title of Scenario Modeled

   ii. Node Identification Label

   iii. Node Elevation (ft)

   iv. Node Demand (gpm)

   v. Calculated Hydraulic Grade (ft)

   vi. Pressure (psi)

10. Design Conclusions

a. Prepare text discussing hydraulic analysis results for all modeled scenarios.

b. Confirm and discuss that pipe velocity and pressure estimates, calculated using demand flow operating conditions (with required fire flow), have met specified criteria.

c. Discuss any potable waterline oversizing required by the Town over and above what is necessary for the development's potable water needs.

d. Discuss any pressure zone considerations and requirements. Discuss locations, settings, and proposed operation of any PRV's, zone breaks, etc.

e. For phased developments, discuss phased construction of the potable water distribution system and confirm that potable water pipes are sized appropriately to meet the design flow with fire flow demand, velocity, and pressure requirements during the interim conditions.

11. Copies

a. Provide a minimum of three (3) certified copies of the Hydraulic Analysis Report for review and approval by the Town Engineer.

b. The Town may require electronic copies of the hydraulic models be submitted.

D. NON-POTABLE IRRIGATION SYSTEM – DESIGN REPORT

The objective of the non-potable irrigation system design report is to assist the Design Engineer with designing a non-potable irrigation system and storage facility to adequately serve peak season irrigation demands while adhering to the design requirements set forth in these criteria.

The non-potable irrigation system design report shall include, but is not limited to, the following information:

1. Title Page

a. Report Title.

b. Project name and location.

c. Name, address, and phone number of:

i. Owner
ii. Developer
iii. Design Engineer that prepared the report.

d. Report preparation date.

2. Engineer Certification Sheet

a. The report shall be prepared by or under the direct supervision of a Professional Engineer, licensed to practice in the State of Colorado, possessing adequate experience in the design of non-potable irrigation systems.

b. The report shall contain a certification sheet indicating that the design was prepared under the direct supervision of the licensed engineer and shall contain his/her signature and registration stamp with date of certification.

3. Table of Contents

4. Project Description and Location

a. Clearly state the location of the project and the nature of the proposed development. Provide a site vicinity map specifying the project's geographical location and the project area in acres.

b. Provide a site plan map identifying the project area and location of the non-potable storage facility (pond), pump station, discharge/fill lines, and overflow works with an analysis of downstream impacts.

c. Indicate if the non-potable system will be phased. Elaborate on the anticipated timing of the project phasing and how it will affect the overall design and construction of the non-potable irrigation system.

d. If connection is planned to an existing non-potable irrigation system, identify locations of pipe connections. Provide the pipe diameter, pipe material, and year of installation of the existing system and/or point of connection.

5. References and Appendices

a. Provide a page referencing all design criteria, resources, and modeling software used in preparing the non-potable irrigation system design report.

b. Provide appendices as necessary to include supplementary information.

6. Non-Potable Irrigation System Report Requirements and Assumptions

a. All equations used, assumptions, demand calculations, design methodologies, essential requirements, parameters, and constraints shall be clearly shown.

b. Indicate any software package(s) and version used for the non-potable irrigation system pipe modeling.

c. Provide calculations for determining irrigated acreage, required storage volume, pond design including high and low operating elevations, overflow works, watering requirements, application rates, and design flow.

d. Provide the number and type of pumps, motor horsepower, system head curves, head computations, discharge pressure, and any other pertinent information for the pump system design.

7. Discussion Items

a. Discuss specific design features of the non-potable irrigation system and their requirements, including but not limited to, non-potable/potable water sources and means of delivery into the system, pond lining and aeration system, pond shoreline treatment, overflow works, and pond design.

b. Discuss general design requirements for the pump station, including but not limited to, power and electrical requirements, control and monitoring systems, and building requirements.

c. Discuss water rights issues, including water rights available, needed and means of supplying adequate water demands.

8. Non-Potable Irrigation System Analysis and Modeling

The non-potable irrigation system shall be modeled for the static scenario and the design irrigation demands scenario. Refer to the previous section on potable water systems for modeling procedures and report results requirements.

9. Non-Potable Irrigation System Design Conclusions

a. Discuss hydraulic analysis results for all modeled scenarios.

b. Confirm and discuss that the pipe velocity and pressure estimates, calculated using the non-potable irrigation demand, have met specified criteria.

10. Copies

a. Provide a minimum of three (3) certified copies of the Non-Potable Irrigation System Report for review and approval by the Town Engineer.

b. The Town may require electronic copies of the non-potable irrigation system hydraulic models be submitted.

1.07 SANITARY SEWER LAYOUT REQUIREMENTS

A. GENERAL

1. Sanitary sewers are designed to convey the spent water supply of the community, industrial wastes, and unavoidable amounts of groundwater infiltration to a satisfactory point of treatment and disposal. All waters not containing impurities which are actually or potentially objectionable shall be excluded from the sanitary system. All designs and the construction of sanitary sewer collection systems **must** exclude rainwater contributions from roofs, streets, and other areas, including groundwater from foundation drains and other sources. These sources of extraneous waters shall not be accepted in the Town of Windsor sanitary sewer system.

2. The purpose of this section is to provide the minimum criteria necessary for system analysis, layout and design of a sanitary sewer collection system.

3. This section is not intended to be inclusive of all situations and the Design Engineer may be required to use additional engineering judgment to meet the overall design intent for constructability and long-term operations and maintenance.

4. This Sanitary Sewer Design Criteria typically applies to sanitary sewer mains eighteen (18″) inches in diameter and smaller. The Town of Windsor reserves the right to make final determinations of the system design based on the best interest of the Town's sewer system.

5. All sewer line design and layout for new developments shall conform to these Standards and the Town's Sewer Master Plan (SMP) and other applicable Comprehensive Master Plans, codes and standards adopted by the Town.

6. All sewer lines and their appurtenances shall be installed in dedicated road rights-of-way, beneath the street surfaces. Sewer lines to be installed in exclusive easements and rights-of-way may be approved when, as determined by the Town Engineer, it is not practical to make such installation in the dedicated street.

7. Sewer lines shall not be installed beneath any concrete flatwork such as sidewalks, curb and gutter, and cross pans, except when the sewer lines are crossing the concrete installation. All Portland Cement Concrete Pavements (PCCP) are an exception to this requirement.

8. Additionally, it is critically important within each development project area that the site layout be designed in a manner that accommodates acceptable access for future maintenance by the Town's Sewer Department.

B. DESCRIPTION

The Town's Public Sewer System includes interceptor, trunk, and collection mains, (gravity and force), water services, and related appurtenances. Other specific Public Sewer System components may include lift stations.

1. Interceptor and Trunk Mains. A sanitary sewer interceptor or trunk main is a large diameter sewer line that collects sewage flows from the collection main and transports those flows downstream to the wastewater treatment facility. Sanitary sewer interceptor/trunk mains are larger than fifteen (15″) inches in diameter. There shall be no individual service taps allowed on sanitary sewer interceptor/trunk mains without prior written approval of the Town Engineer or from the Town's Sewer Department; the Town Engineer must first approve any type of connection to an interceptor/trunk main.

Sanitary sewer interceptor/trunk mains are usually constructed within an approved dedicated easement following drainage patterns. The size of these mains will usually be determined by basin analysis and design of minimum pipe size and slope.

2. Collection Mains. A sanitary sewer collection main is a sanitary sewer line that gathers wastewater flows directly from individual sanitary sewer services and transports those flow to an interceptor/trunk sanitary sewer main. Sanitary sewer collection mains within the Town's system are typically eight (8″) inch, ten (10″) inch, twelve (12″) inch, and fifteen (15″) inch, diameter.

   Sanitary sewer collection mains are usually constructed within the road right-of-way or an approved dedicated easement. The size of these mains will usually be determined by the minimum pipe size and slope.

3. Force Mains. Force mains are sanitary sewer lines that operate under pressure rather than by gravity flow and transport wastewater flows to an interceptor/trunk sewer or to the wastewater treatment facility directly. Sizing of force mains is dependent upon sewerage volume, velocity, head loss, elevations, and discharge conditions, among other considerations.

4. Sanitary Sewer Services. Sanitary sewer services include all piping, fittings, and appurtenances used to convey sanitary sewage from a structure's plumbing system to a sanitary sewer collection line. Sanitary sewer services are typically four (4″) inch or six (6″) inch diameter.

5. Minimum Allowable Pipe Sizes. The minimum allowable pipe diameter for sanitary sewer mains in the Town's collection system shall be eight (8″) inches. The minimum individual service size is four (4″) inches.

   The Town's Sewer Master Plan sizing layout may override these general standards. The Town Engineer may also require oversizing of certain sewer lines, beyond those identified in the Sewer Master Plan.

C. SYSTEM LAYOUT

The following design layout criteria for sewer lines are required for all new construction, rehabilitation, and retrofit installations:

1. Horizontal Requirements.

   a. Location:

      i. Within platted rights-of-way and improved public streets, sewer lines should generally be located at the centerlines, where feasible, or symmetrically within a dedicated exclusive easement of appropriate width.
      ii. In all cases, sanitary sewer manhole placement shall not interfere with the vehicular tire traffic pattern. The centerline of sanitary sewer collection lines shall not be placed closer than eight (8′) feet to the lip of the street gutter without prior acceptance by the Town Engineer.
      iii. Sewer lines shall not be installed beneath any concrete, such as sidewalks, curb and gutter, and cross pans, except when the sewer line is crossing the concrete installation.
      iv. In cases where a raised median is proposed, the sewer main shall be located ten (10′) feet east or south, outside of the raised median flowline.
      v. A sanitary sewer main serving one (1) individual lot shall extend all the way across the frontage for that lot. Exceptions to this requirement shall be determined on a case by case basis by the Town Engineer.
      vi. Sanitary sewer mains shall be extended offsite when required to tie into the existing sanitary sewer collection system.

vii. Generally, manholes shall not be placed in the center of roundabouts, but rather designed to be placed into one quadrant, just off the truck apron.

b. Separation:

i. Wet utilities (*e.g.* public potable water, public or private stormwater, public or private reclaimed water and any related appurtenance) running parallel to a public sewer line and/or related appurtenance, shall be no closer than ten (10′) feet, measured from nearest outside edge of each pipe or related appurtenance.

ii. Dry utilities (*e.g.* natural gas, electric, cable TV, Telephone/Communications and any related appurtenance) running parallel to a public sewer line and/or related appurtenance, shall be no closer than six (6′) feet, measured from nearest outside edge of each pipe or related appurtenance.

iii. Upon maturity, outside edges of any shrub or bush shall be no closer than five (5′) feet to the nearest outside edge of a sanitary sewer system main and/or any related appurtenance. Upon maturity, the outside edge of any tree trunk shall not be closer than ten (10′) feet to the nearest outside edge of a sanitary sewer system main and/or any related appurtenance.

iv. Berms greater than two (2′) feet high and/or with side slopes steeper than four to one (4:1), shall not be allowed within ten (10′) feet of a sanitary sewer system main and/or any related appurtenance.

v. Parallel installation of other utilities in exclusive sewer line easements is not permitted.

c. Alignments.

i. Straight. All sanitary sewer mains shall be laid with straight alignments between manholes. Joint deflection or bending of the pipe barrel shall not be allowed.

ii. End of Run. All sanitary sewer lines shall end in a manhole, including lines that may terminate at a future construction phase line.

A. Cul-de-sacs. Sanitary sewer collection lines shall extend beyond the center of the cul-de-sac a minimum of ten (10′) feet and terminate in a manhole.

B. Lot Extensions. Sanitary sewer line installations serving one (1) individual lot shall complete the extension across the entire frontage for that lot. Exceptions to this requirement shall be determined on a case by case basis by the Town Engineer

2. Vertical Requirements.

a. Depth of Bury:

i. Cover. Sanitary sewer collection mains shall have four (4′) feet minimum depth of cover, as measured from finished grade to top of pipe.

ii. Typical. Sanitary sewer collection mains should generally be placed at ten (10′) feet of cover, as measured from finished grade to top of pipe.

iii. Non-compliance. Where grading, existing field conditions, or service constraints demonstrate that a sanitary sewer main must have less than four (4′) feet of cover or when sewer main installation is deeper than twenty (20′) feet at the invert (flowline), additional design requirements and alternative pipe and/or bedding materials shall be considered.

iv. "Shallow Sewer". When the elevation difference between the finished lot grade at the building line and the top of the sanitary sewer collection main is less than nine (9′) feet, the Construction Drawings shall indicate that the lot is

served by a “shallow sewer” and appropriate elevation information shall be given.

b. Vertical Separation:

i. Clearance. All sanitary sewer lines, including sewer service lines, shall have a minimum eighteen (18″) inches vertical separation from all utilities, measured from outside diameter.

ii. Waterline Crossings. Where sanitary sewer lines cross beneath potable waterlines with less than the eighteen (18″) inches vertical separation, where sanitary sewer lines cross above potable waterlines, or where the ten (10′) foot horizontal clearance between potable waterlines and sanitary sewer lines cannot be maintained, pipe encasement of the sanitary sewer shall be designed and constructed so as to protect the potable waterline.

iii. Centered. In all cases, the crossing pipes shall be centered over each other so that the joints are at a maximum distance from the crossing.

c. Alignment and Grade:

i. Changes in Alignment. When a change in direction or slope of a sanitary sewer line is proposed, the change in alignment shall occur only at a manhole.

ii. Slope. Sanitary sewer mains shall be designed to maintain a minimum, positive grade between all manholes. The slope (grade) of the pipe shall be denoted on the Construction Drawings mathematically by percent or decimal of slope. All manholes shall be denoted with a top-of-ring elevation, manhole diameter, invert elevation(s), vertical datum elevation, and a horizontal reference station.

iii. Interceptor/Trunk Mains. Sanitary sewer interceptor/trunk mains larger than fifteen (15″) inches in diameter shall be designed and installed strictly to grade to provide design capacity. All pipes shall be constructed to the lines, grades and elevations shown on the construction plans.

3. Crossings Requirements.

a. General. When a sewer line crosses a sanitary or storm sewer, crosses another public or private utility, irrigation or drainage ditch, the crossing design and construction shall protect the main utility’s structural integrity, prevent deterioration of the sewer line, and mitigate future system impacts and costs of repair. The agency responsible for the utility, ditch, railroad or other structure crossed by the sewer line may also impose additional criteria. All crossing(s) shall be shown in plan and profile view, clearly identified and dimensioned on the construction plans.

b. Sewer Line Crossing a Waterline. When a sewer line crosses a waterline, the waterline should cross above, with a minimum of eighteen (18″) inches vertical separation AND maintain the required bury depth for the waterline. If there is less than eighteen (18″) inches vertical separation, the sewer line shall be encased with concrete for ten (10′) feet on each side of the crossing and the waterline shall be a twenty (20′) foot section of pipe centered on the crossing. The Town Engineer may also require encasement, joint wrap, or the use of solid steel casing pipe and casing seals. In some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe, from manhole to manhole.

c. Sewer Line Crossing a Dry Utility Line. When a sewer line crosses these types of systems, typically the sewer line crosses below the dry utility, with a minimum of eighteen (18″) inches vertical separation from such system AND maintain the

required bury depth of the sewer line. If there is less than eighteen (18″) inches vertical separation, the dry utility shall be encased in high density polyethylene pipe (HDPE), Standard Dimension Ration eleven (SDR 11), from edge to edge of the easement or right-of-way, or ten (10′) feet on either side of the sewer line, whichever is greater.

d. Sanitary Sewer Line Crossing Over a Waterline. When a public waterline crosses under a sewer line, encase the sewer line no matter what the vertical clearance is, for a distance of ten (10′) feet each side of the crossing. If the vertical separation is less than eighteen (18″) inches, the waterline shall be installed in a twenty (20′) foot section of steel casing pipe, centered on the crossing. The proper corrosion protection is required where the steel casing pipe is utilized. In some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe, from manhole to manhole.

e. Sanitary Sewer Line Crossing Under a Storm Sewer Line. If the sewer line is less than eighteen (18″) inches below a major storm sewer (thirty six (36″) inch and larger), the sewer line shall be encased in steel casing pipe and the crossing design shall be reviewed and approved by the Town Engineer.

f. Sewer Line Crossing Under a Ditch. When a sewer line crosses under a ditch, the Ditch or Irrigation Canal Company shall be contacted for approval of each crossing. In addition to these standards, the Ditch Company may modify or add to the requirements of these Standards, provided their requirements are more stringent.

   i. Casing Pipe. A casing pipe encompassing the sewer line shall be installed beneath all ditches. Depending on the configuration of the ditch, the casing pipe shall extend a minimum of ten (10′) feet beyond any toe or top of slope of the ditch.
   ii. Material and Class of Pipe. The type of material and class of pipe to be utilized in these crossings will be as specified by the Town Engineer.
   iii. Cover. Sanitary sewer line crossings under any open ditch shall have a minimum bury depth of five (5′) feet, measured from the flowline of the ditch to the top of the casing pipe.
   iv. Cut-off Wall. Typically, a concrete cut-off wall shall be placed at both ends of the casing pipe; extending vertically to the maximum free surface water elevation of the ditch. In some cases, with the Ditch Company approval, a clay cut-off wall may be used instead of concrete.
   v. Ditch Rehabilitation. All ditches shall be restored to original condition, according to the ditch company's material and construction criteria.

g. Concrete Encasements. All concrete encasements shall be installed per these specifications and the Town's Standard Details. Additional support may be required by the Town Engineer where large diameter lines cross. Encasement of sewer lines shall be a minimum of six (6″) inches thick (measured at the bell end) and extend a minimum of one (1′) foot on each side of any joints.

h. Right Angle Crossings. Crossings of sewer lines shall be at right angles and meet the requirements given above. Parallel installation of other utilities in exclusive sewer line easements is not permitted.

i. Bored Crossings. Bored utility crossings shall have a minimum twenty four (24″) inches of vertical clearance from the outside diameter of the utility casing to the outside diameter of the sewer line if the bored utility crosses above the sewer line and a minimum of thirty six (36″) inches of vertical clearance from the outside

diameter of the utility casing to the outside diameter of the sewer line if the bored utility crosses below the sewer line.

j. Conflicts. If there are horizontal or vertical clearance conflicts between the sewer line and a utility, the Town may require that the sewer line be redesigned so that it can be lowered, raised, or realigned in order to maintain the required clearances. For a sewer line crossing situation not specifically mentioned in this section, the crossing requirements provided herein shall be applied to that particular situation to the best extent possible.

4. Dead-end Sewer Lines.

a. Manholes. All dead-end sewer lines shall terminate with a manhole placed on the end of the line.

b. Sewer Lines in Cul-de-sacs. Sanitary sewer lines serving a cul-de-sac shall be extended to within eight (8′) feet of the lip of street gutter at the end of the cul-de-sac and shall have a manhole installed on the end of the line.

D. PHASED INSTALLATION

1. If sanitary sewer collection system phasing is proposed within a development project area, the phasing shall be clearly identified on the master utility plan. Construction Drawings, including plan and profile sheets, shall clearly show and label the phasing transitions in the sanitary sewer design.

2. The phased sanitary sewer system shall be designed for full build-out of the development being served including any additional offsite flows that must be passed through the development and adhere to all sanitary sewer system and hydraulic design requirements provided in these criteria.

3. Locate sanitary sewer manholes at the end of each phase or stub-out. The stub-out shall be shown on the sanitary sewer plans.

4. Phased sewer line or stub-out construction shall be extended a minimum of ten (10′) feet, or a distance equal to the depth of the pipe, whichever is greater, beyond phased street paving to avoid asphalt removal during excavation for future connections.

5. A stub-out for future connection may be provided for an adjoining phase or adjacent, future developments.

6. The stub-out design and installation shall maintain both vertical and horizontal alignment in accordance with these Criteria. The stub-out shall be shown on the sanitary sewer plan and profile sheets with the length and end of pipe invert indicated.

7. The sewer main stub-out installation shall end at a terminal manhole with a ten (10′) foot stub extending upstream out of the manhole and shall be sealed with a removable water-tight plug until the time of future connection.

8. Sanitary sewer line stub-outs that are not utilized shall be abandoned at the connection to the main sewer line, as directed by the Town Engineer.

1.08 SEWER APPURTENANCES

A. MANHOLES

1. General.

   a. Manholes shall be provided at the end of each sewer line, at all changes in alignment, grade, size, and at all pipe intersections used.

   b. There shall be no more than three (3) sewer lines designed to discharge into any one (1) proposed manhole.

   c. Cleanouts shall not, in any circumstances, be substituted for manholes.

   d. Manholes for sanitary sewer installation shall be pre-cast concrete; cast-in-place concrete manholes shall only be allowed upon approval of the Town Engineer or the Town's Sewer Department. All constructed manholes shall be sealed tightly to prevent storm or other non-sewage flows from entering the sanitary sewer system.

   e. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the manhole interior and lid and cover shall be provided.

2. Manhole Location and Placement.

   a. All manholes shall be located in a dedicated street right-of-way or within a dedicated exclusive easement of appropriate width. Approval by the Town Engineer is required for all other manhole locations.

   b. The center of manholes shall not be placed closer than eight (8′) feet to the lip of the street gutter without prior approval by the Town Engineer.

   c. The edge of the manhole cover shall be located a minimum of five (5′) feet from the edge of crosspans, wherever feasible.

   d. Manholes not within road rights-of-way should be located in areas not subject to flooding by stormwater runoff. Manholes shall not be located in areas of stormwater ponding or detention.

      i. When the location of manholes in stormwater runoff areas cannot be avoided, a solid, bolt down, manhole cover, with an integral "O-ring" type gasket, shall be used.
      ii. Manholes located within the one hundred (100-yr) year flood plain shall have a solid, watertight, bolt down manhole cover. The manhole ring shall be bolted to the manhole cone, and all manhole joints and grade rings shall be sealed from the outside with an approved seal wrap.

   e. Manholes outside of road rights-of-way shall be provided with direct access by means of an all-weather road. Requirements for an all-weather road are as follows:

      i. All-weather roads shall be designed to support Town of Windsor Sewer Department maintenance vehicles up to thirty five (35) tons with a minimum turning radius of sixty (60′) feet.
      ii. At a minimum, all-weather roads shall be ten (10′) feet wide with eight (8″) inches of compacted aggregate base course. Subgrade preparation, compaction, and aggregate base course shall be in accordance with the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets**.

iii. If the all-weather road terminates at the manhole it provides access to and is longer than fifty (50′) feet in total length, an appropriately sized turn-around shall be provided.

iv. The Design Engineer shall verify and certify that these minimum requirements for the all-weather road are suitable and adequate for the specific project conditions.

v. If the all-weather road cannot be located within a dedicated sanitary sewer easement, an appropriate width sanitary sewer access easement shall be dedicated.

f. Manholes placed within areas designated by the Town as “restricted access”, shall have a locking lid with the rim permanently bolted to the manhole cone section.

g. Manholes shall not be located in concrete areas, such as sidewalks, cross pans, aprons, driveways, or curb and gutters.

3. Manhole Inverts.

a. The inverts through manholes shall have a minimum one tenth (0.1′) foot channel drop in elevation on straight through alignments. Manholes with horizontal flowline channel alignments thirty (30°) degrees off straight, and larger, and/or with interconnecting mains, shall have a minimum two tenths (0.2′) foot drop between all incoming flowline channel invert elevations and the downstream flowline channel invert elevation.

b. In the case where cast-in-place manholes are to be installed over existing sanitary sewer mains, the existing sewer pipe grade determines the elevation drop across the manhole, by constructing the cast-in-place manhole over the existing, straight sewer main and removing the upper half of the pipe.

c. Where a smaller sanitary sewer main joins a larger one, the smaller sanitary sewer main crown elevation shall match the crown elevation of the larger sanitary sewer main. This includes sanitary sewer service lines where permitted.

d. Manhole inverts shall be shaped or filleted to match the outlet pipe, to prevent solids deposition.

e. Where the invert elevation difference between the invert in and invert out is twenty four (24″) inches or more, an exterior drop apparatus shall be provided. Drop manholes are discouraged and may be allowed on a case by case basis. Prior to approval of a drop manhole, the Design Engineer must provide alternatives for review and consideration by the Town. Refer to Town of Windsor Standard Detail Drawings for Drop Manhole layout.

i. Drop manholes can enhance the release of hydrogen sulfide gas that can lead to corrosion and noxious odors in the interceptor and collector system and should be constructed with an outside drop connection.

ii. Manholes located in areas with a high probability of hydrogen sulfide corrosion shall be constructed with, or coated with, hydrogen sulfide resistant materials. Typical locations for such manholes include, at force-main discharge points, drop manholes or on large diameter mains with turbulent flows. The Town Engineer shall first approve all cases and locations, prior to final design.

iii. Encase the entire outside drop connection in concrete prior to backfilling due to the unequal earth pressure that would result from backfilling near the manhole.

f. The flow channel through manholes shall be made to conform to the shape and slope of the sewers. The sewer pipe should be constructed through the manhole when alignment allows.

g. A sloped bench shall be provided on each side of any manhole channel. The bench should be sloped no less than the manhole diameter. A lateral sewer, service connection, or drop manhole must not discharge onto the bench surface.

4. Manhole Size and Spacing.

a. The minimum internal diameter of the manhole barrel shall be forty eight (48″) inch diameter for sanitary sewers of twelve (12″) inches or less, sixty (60″) inch diameter for sewers fifteen to twenty seven (15″ - 27″) inches, and seventy two (72″) inch diameter for sewers thirty (30″) inches and larger.

i. Manholes shall be so constructed as to form a circle in a horizontal plane.
ii. The internal diameter shall be maintained to a point between fifty four (54″) inches to forty eight (48″) inches from finished grade. From that point, the manhole shall be eccentrically tapered to the internal diameter of twenty four (24″) inches. The point at which the internal diameter is twenty four (24″) inches shall be not more than twenty four (24″) inches or less than eighteen (18″) inches below the finished grade of the manhole cover.

b. Maximum allowable spacing for manholes shall be four hundred (400′) feet for sewers fifteen (15″) inches in diameter or less, and five hundred (500′) feet for sewers eighteen (18″) inches to thirty (30″) inches in diameter.

5. Surface Grades.

a. The surface grade (elevation) of the manhole lid shall be adjusted to exactly match final street grade prior to initial acceptance.

b. When manholes are located in open fields and cultivated areas, where practical, they shall be left between ten to twelve (10″ - 12″) inches above grade, properly marked with a bollard post reference marker painted green. A locking ring and cover shall be required and the manhole shall be surrounded with a four by four (4′ x 4′) foot concrete pad six (6″) inches thick.

c. The bollard post shall be a six (6″) inch, galvanized, post filled with concrete and painted green. Location direction shall be stamped onto the concrete on top of the post and distance to the centerline of the manhole cover shall be painted on the post in red.

d. Final elevation of all manhole rims is to be at the discretion of the Town of Windsor.

B. PIPE MATERIAL

1. Sanitary sewer collection mains shall be polyvinyl chloride (PVC) SDR 35, colored green, non-pressure sewer pipe suitable for sanitary sewer flows.

2. Alternative pipe materials shall only be used upon approval of the Town Engineer and shall be used in the following situations:

a. Where sanitary sewer collection mains are installed less than four (4′) feet measured from the finished grade elevation to the top of the pipe, gravity sewer ductile iron pipe shall be used.

b. Where sanitary sewer collection mains are installed deeper than twenty (20′) feet at the invert, polyvinyl chloride (PVC) SDR 26 shall be used.

c. Where sanitary sewer collection mains are required to be encased for crossing purposes, polyvinyl chloride (PVC) pressure pipe, AWWA C900 or C905, may be used in lieu of encasement.

d. Where sanitary sewer collection mains are installed in bored casing pipes, if the joints are required to be restrained, either gravity sewer ductile iron pipe with mechanical joints shall be used or PVC, SDR 26, non-pressure sewer pipe with mechanical joints.

3. Changes between pipe materials are not permitted along a continuous sewer main. The alternative pipe material shall be installed from manhole to manhole.

C. ENCASEMENTS AND BORINGS

1. Concrete encasements shall be installed where called for on the Construction Drawings, where required by these Specifications, or where directed by the Town Engineer. Encasement requirements shall ultimately be determined by the Town on a case by case basis.

2. All encasement(s) shall be shown in plan and profile view, clearly identified and dimensioned on the construction plans. The encasement design and construction shall protect the main utility's structural integrity, prevent contamination from or to the sewer line, and mitigate future system impacts and costs of repair.

3. Where sanitary sewer lines cross other utilities, structures, drainages, etc., as detailed herein in Section **1.07.C.3., Crossing Requirements**, sewer pipeline encasement shall be designed and constructed so as to protect the sanitary sewer line and the appurtenance being crossed.

4. The sewer line shall be encased with concrete for ten (10′) feet on each side of the crossing and the sewer line shall be a twenty (20′) foot section centered on the crossing. The proper corrosion protection is required whenever DIP is utilized. Longer encasements may be required depending on the encasement situation. The Town Engineer may also require encasement, joint wrap, or the use of solid steel casing pipe and casing seals. In some cases, with prior approval, PVC pressure pipe may be used in lieu of an encasement if the sewer line is AWWA C900 or C905 pipe that extends from manhole to manhole.

5. Encasements shall be a minimum of six (6″) inches thick and extend a minimum of one (1′) foot on each side of any joints. All concrete encasements shall be installed per these specifications and the Town's Standard Details. Additional support may be required by the Town Engineer where large diameter lines cross.

6. Provide suitable backfill or other structural protection to preclude settling or failure of the higher pipe.

7. Installation of sanitary sewer lines may require a bored casing pipe to facilitate main installation. Borings shall be installed where called for on the Construction Drawings, where required when crossing another agency's right-of-way or easement, where required by these Specifications, or where directed by the Town Engineer. Boring requirements shall ultimately be determined by the Town on a case by case basis.

8. The type of bored casing material, its bore length, carrier pipe material and the various properties shall be determined by the Design Engineer and shall be approved by the Town Engineer. Cathodic protection of steel casing pipes shall be included in all design evaluations.

9. If a bored casing for a sanitary sewer line crosses another utility line, the crossing should have a minimum twenty four (24″) inches of vertical clearance from the outside diameter of the casing pipe to the outside diameter of the utility line if the bored casing crosses above the utility and a minimum thirty six (36″) inches of vertical clearance from the outside diameter of the casing pipe to the outside diameter of the utility line if the bored casing crosses below the utility.

10. If there are horizontal or vertical clearance conflicts between the sanitary sewer line and a utility, the Town may require that the sewer line or the utility line be lowered, raised, or realigned in order to maintain the required clearances. For a sanitary sewer line crossing situation not specifically mentioned in this section, the crossing requirements provided in these Criteria shall be applied to that particular situation to the best extent possible.

D. CORROSION PROTECTION

1. All ductile iron pipe, fittings, and connections shall be protected as specified in this section.

2. Polyethylene encasement shall be applied to all ductile iron pipes, fittings, connections, and other appurtenances. The encasement shall be in tube or sheet form sized for each pipe diameter, eight (8) mils thickness, with a two (2″) inch wide, ten (10) mils thick, polyethylene pressure sensitive tape to close seams or hold overlaps.

3. All polyethylene tubing, tape, and installation shall conform to AWWA C-105, latest designation, specifications.

4. The polyethylene encasement shall prevent contact between the pipe or fitting and surrounding backfill and bedding material, but is not intended to be airtight or watertight. All rips, punctures or other damage shall be repaired with adhesive tape or with a short length of new encasement wrapped around the damaged area secured in the same manner as overlaps. Overlaps shall be a minimum of one (1′) foot at the end of each section and shall be secured by use of the polyethylene pressure sensitive tape, plastic string, or other material capable of holding the encasement in place until backfilling operations are completed.

5. Prior to installing the polyethylene encasement, clumps of mud or other contaminants shall be brushed off the pipe or fitting surface. Polyethylene tubes shall be installed in accordance with ANSI A21.5 Method A. Method A requires tubes to be overlapped one (1′) foot and secured with tape, and the slack width to be taken up on top of the pipe and taped at the quarter points.

E. CATHODIC PROTECTION

1. A certified Geotechnical Engineer must perform a soil resistivity survey of the construction area or a soil-test evaluation in strict accordance with AWWA C105, Appendix A. The results of the evaluation along with all survey data and calculations, together with the service history of other existing pipe in the area shall be submitted to the Town for consideration and review.

2. The Water-Saturated Soil Box method shall be used to measure the resistivity of the soil. Alternative methods may be used only upon approval of the Town Engineer.

3. The distance between sample locations shall be at the discretion of the Town Engineer.

4. If the soil-test evaluation concludes the soil is corrosive to DIP, metallic fittings, or steel casing pipe, the Design Engineer must submit to the Town for approval a comprehensive plan with proposed design for cathodic protection. The design shall be in accordance with the National Association of Corrosion Engineers (NACE) RP0169 latest revision.

F. SANITARY SEWER SERVICES

1. All sanitary sewer service lines, from the point of connection (including the physical connection joint to a main or to a manufactured wye/saddle) into a residential, commercial or industrial building, shall be owned and maintained by the respective building and/or property owner. Additionally, that portion of the service line situated within a right-of-way or easement shall be subject to review, approval, and inspection of the design, materials, and installation of said service line, pursuant to these Standards and the Town’s Municipal Code, Title 13.

2. Sanitary sewer service lines shall not be installed in trenches with other conduits/utilities. A service line shall be separated from other conduits a minimum of ten (10′) feet horizontally and eighteen (18″) inches vertically.

3. A sanitary sewer service line for a given lot must be tapped on the sewer main within the confines of the property lines extended.

4. The sewer main to be tapped must extend along the entire length of the front lot line of the property to be served.

5. No sanitary sewer service taps shall be made on a storm sewer or drainage line.

6. A separate sanitary sewer service line must serve each structure.

7. No sanitary sewer service lines shall cross property lines and shall only be used on that single property.

8. No compound sanitary sewer taps are allowed.

9. All sanitary sewer service lines shall be constructed on the shortest and straightest route possible.

10. Where feasible, sanitary sewer service lines shall be located a minimum of ten (10′) feet downstream (measured along the sewer main) of the potable water service at the center of the lot served. Sewer and water service lines must be a minimum of ten (10′) feet apart horizontally, or concrete encasement or special protection of the sewer line will be required.

11. At no time shall the service line be closer than five (5′) feet to the side property line.

12. That portion of the sanitary sewer service line between the main and the property line, or within the right-of-way/easement, when installed, shall be in a continuous straight line, with no additional bends or fittings beyond the forty five (45°) degree bend and wye at the main. Service lines stubbed into the property line shall extend into the property at least five (5′) feet.

13. Sanitary sewer service lines for lots at the end of a cul-de-sac street shall be connected onto the sewer main downstream of the manhole through the use of service “wyes”, or connection into the end manhole, two (2) maximum permitted. The service line between the main and the property line in cul-de-sacs shall be in a continuous straight line. No service line may be constructed through or in front of any adjoining property.

14. During the placement of concrete for curb and gutter, sanitary sewer service line locations shall be marked with an “S” on the face of the curb directly above the service location.

15. Under no condition is a sanitary sewer service line to be located under driveways, trees, or other permanent structures. Certain lots (such as in cul-de-sacs) may have the sanitary sewer service line located anywhere along the frontage but shall be a minimum of five (5′) feet inside the property being served.

16. Sanitary sewer service line stub-ins shall be plugged with a watertight compression stop. The end of the service line shall be marked with a two by four (2x4) wood stake, set vertically in the ground, extending four (4′) feet out of the ground, with the top two (2′) foot painted green, prior to backfilling.

17. Measurements of the service from the main to the property line and depth of stub at property line shall be taken by the Contractor and provided to the Town on the “As-built” Project Record Drawings.

18. Sanitary sewer service cleanouts are not permitted in the public right-of-way or exclusive sanitary sewer easement.

19. No more than two (2) forty five (45°) degree bends shall be allowed in any sanitary sewer service line. A cleanout will be required for each one hundred (100′) feet of service line or portion thereof.

20. Service Connections (Wyes).

    a. Sanitary sewer service connections, wyes, shall be separated by at least five (5′) feet, measured along the sanitary sewer main length, including when wyes are on opposite sides of the sanitary sewer main.

    b. Sanitary sewer service wyes shall be a minimum two (2′) feet from all joints or bells.

    c. Sanitary sewer service wyes and services shall be installed in conjunction with new sewer mains.

    d. A sanitary sewer service wye should be used in cul-de-sacs when possible instead of connecting into manholes.

    e. No more than two (2) sanitary sewer service connections shall be allowed into a manhole. Service connections into a manhole shall only be allowed upon approval of the Town Engineer.

21. Sewer Services.

    a. Sanitary sewer services shall be polyvinyl chloride (PVC) SDR 35 pipe.

    b. Sanitary sewer services are typically four (4″) inches or six (6″) inches in diameter.

    c. If a sanitary sewer service line is required to be larger than six (6″) inches in diameter, although considered private and maintained by the property owner, the design and connection to the sanitary sewer system shall be considered as a collection main.

    d. The slope on sanitary sewer service lines shall be as follows:

        i. Maximum grade of four (4″) inch sanitary sewer services shall be fifteen (15%) percent.
        ii. Maximum grade of six (6″) inch sanitary sewer services shall be twelve (12%) percent.
        iii. Minimum slope for four (4″) inch services shall be one quarter (¼″) inch per foot, a two (2%) percent slope.
        iv. Minimum slope for six (6″) inch services shall be one eighth (⅛″) inch per foot, a one (1%) percent slope.

22. Sanitary sewer service connections to interceptor or trunk lines are not permitted unless approved otherwise by the Town.

23. Not withstanding the applicable provisions of the Town's Municipal Code, Chapter 13, Article I, Sewers, the following service types shall apply:

    a. Residential, Single Family, Duplex or Two-unit Townhome. A type of dwelling unit whereby each unit is situated upon its own separate, platted lot, shall be serviced individually by one (1), service line for each platted lot. The maximum number of

allowable living units that can be serviced by this tap size is two (2) single family living units.

b. Residential, Multi-Family. A type of dwelling unit containing three (3) or more residences whereby each residence is not situated upon its own separate, platted lot, shall be serviced by one (1) common private service line for each dwelling unit.

c. Commercial. A building with one (1) or more internal tenant spaces whereby each tenant space is not situated upon its own separate, platted lot, may be serviced by one (1) common private service line for each building. The Design Engineer shall submit calculations indicating required size for each service(s) which shall be reviewed and approved by the Town Engineer.

d. Industrial. A building with one (1) or more internal tenant spaces whereby each tenant space is not situated upon its own separate, platted lot, may be serviced by one (1) or more common private service line for each building and/or tenant space., Where specified by the Town Engineer, in order to have samples taken if industrial waste is probable, a manhole may be required to be located on the industrial service line to enable sampling prior to fluids reaching the sanitary sewer main line. The Design Engineer shall submit calculations indicating required size for each service(s) and sampling manhole details, which shall be reviewed and approved by the Town Engineer.

24. Contractor shall extend future sewer service taps from the main to the property line in conjunction with the installation of the sewer main and prior to construction of street improvements.

25. Sanitary sewer services not being utilized shall be abandoned. Whenever a sewer service will be discontinued permanently, the service line shall be uncovered at the sewer main and the service connection removed, plugged and sealed with concrete.

G. TAPPING THE SEWER MAIN

1. Where sewer service wyes have not or could not have been installed in the existing sanitary sewer collection main, the Town Engineer, on a case by case basis, shall review and approve the application to tap the existing main and determine the appropriate method of construction.

2. Having obtained all necessary approvals, the area around the main shall be excavated and the line prepared for tapping.

3. All taps shall be machine tapped. The hole and saddle shall be installed so that no projection of the sewer service pipe inside the sewer main shall occur. All edges shall be filed smooth.

4. Approved tees or sewer service saddles shall be used to connect the service line to the sewer main.

5. The connection shall be watertight and at a forty five (45°) degree angle above the pipe horizontal centerline.

6. No aluminum saddles shall be permitted. Only approved sanitary sewer saddles shall be used.

7. All taps shall be a minimum of five (5′) feet apart and shall not be within two (2′) feet of the bell. Service taps shall not oppose each other.

8. Wherever the diameter of the service line is equal to or greater than seventy five (75%) percent of the sewer main diameter, a manhole shall be installed in place of service tap.

9. Service taps into existing manholes shall not be permitted without the written approval of the Town Engineer.

10. Sanitary sewer service connections to existing interceptor or trunk lines are not permitted unless approved otherwise by the Town Engineer.

11. It shall be the Contractor's responsibility to provide all necessary tapping materials prior to installation.

H. GREASE, SAND & OIL INTERCEPTORS

1. Grease Traps:

    a. Reference the Plumbing Code, as adopted by the Town of Windsor.

    b. No more than four (4) fixtures shall be connected to a grease trap.

    c. Dishwashers shall **not** be connected to a grease trap.

    d. No food waste disposal unit shall be connected to a grease trap.

    e. An approved type flow control or restrictor is required prior to the grease trap and must be accessible at all times for maintenance and examination.

    f. Grease traps rated at less than fifty (50 gpm) gallons per minute per one hundred (100 lbs) pounds capacity are not permitted.

    g. Grease traps shall be accessible at all times for maintenance and examination.

    h. Grease trap locations and design shall comply with the appropriate County Health Department requirements.

2. Combination Sand and Oil Interceptors:

    Combination sand and oil interceptors smaller than three hundred (300 gal) gallons shall not be allowed.

3. Venting:

    Interceptors shall be vented in accordance with the Town's current adopted Building and Plumbing Codes. See **Section 02280**, **Waterline Manholes and Vaults**, of these Construction Specifications, for additional information.

4. Domestic Waste:

    Domestic wastewater shall not enter or flow through any portion of an interceptor. All domestic wastewater flows shall connect into a service line downstream of any interceptor.

5. Certification:

    The Design Engineer may be required to certify that the appropriate treatment device was installed in accordance with final, signed, Construction Drawings, and manufacturer's recommendations. A certification form is required and available from the Building Department.

I. UNDERDRAIN PIPES

1. General. Where possible, underwater drain systems should be avoided. If it can be demonstrated that an underdrain system is cost-effective and can be adequately maintained, the Town, on a case-by-case basis, can consider such a system.

2. Underdrains shall be designed by a Professional Engineer.

3. Underdrains **shall not** be connected to the sanitary sewer collection system nor shall they discharge onto the surface or to any other location not approved by the Town. Underdrains shall only discharge into approved discharge locations such as the storm drainage system or designed detention areas.

4. Underdrains may be polyvinyl chloride (PVC) SDR 35, ductile iron, pre-stressed concrete, or other suitable pipe material able to withstand underwater forces and resist buoyancy. Screening chambers shall be provided at all points of intake to underdrain systems.

5. Underdrain pipes shall be designed to the have the same slope as the sanitary sewer main.

6. Minimum allowable street underdrain diameter is six (6″) inches. Street underdrains shall be non-perforated.

7. Outside the street right-of-way or sanitary sewer easement, underdrains shall be perforated and sleeved with a geotextile, polyester, knitted sock.

8. Design of underdrain systems and devices shall provide a positive bar to the entry of material that would contribute to any obstruction of the underwater parts of the system.

9. Underdrain clean-outs or flushing wyes shall be located adjacent to every sanitary sewer manhole and shall be rated for HS-20 traffic loadings. Cleanout risers shall be four (4″) inches in diameter, solvent welded, and shall be designed to avoid damage from ice or frost.

10. Underdrains shall be installed in the sanitary sewer collection main trench a minimum eight (8″) inches vertical clearance below the manhole base and a minimum eighteen (18″) inches horizontal clearance from the outside diameter of sanitary sewer pipe to the outside diameter underdrain pipe.

J. GROUNDWATER BARRIERS/CUT-OFF WALLS

1. Groundwater barriers/Cut-off walls are intended to impede passage of subsurface groundwater through the entire portion of the excavated trench.

2. They shall be installed across the sanitary sewer main, ten (10′) feet upstream of every manhole, in areas where high groundwater is anticipated, and where underdrains are installed.

3. Groundwater barriers/cut-off walls shall be located a minimum of every four hundred (400′) feet on the main sewer trench and at the property line on all services.

4. They shall extend to a point two (2′) feet above the maximum peak wet season level of sub-surface ground water, including locations near or adjacent to a natural waterway, pond/lake and irrigation ditch.

5. Groundwater barriers/cut-off walls shall be installed on both sides of any natural waterway, pond/lake, or irrigation ditch.

K. SPECIAL DESIGNS

1. Stream Crossings.

a. Review and Approval. All proposed stream crossings shall be designed by a Professional Engineer and shall require the review, approval, and written permission of the Town Engineer as well as other affected parties. The Town Engineer shall first approve all requests, cases, and locations, prior to final design.

b. Cover Depth. The depth of all sewers crossing streams shall be at a sufficient depth below the natural streambed bottom to protect the sewer line. Proposed cover, pipe and backfill requirements will be reviewed by the Town on a case-by-case basis and approved only if the proposed sewer crossing will not interfere with future improvements to the stream channel.

c. Horizontal Location: Sewers located along streams shall be located outside of the streambed and be sufficiently removed from the streambed to allow at least minimal future possible stream widening and to prevent pollution by siltation during construction.

d. Structures. The sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be located so they do not interfere with the free discharge of stream flood flows.

e. Alignment. Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and gravity sewer crossings shall be designed to minimize the number of stream crossings.

f. Construction Methods. Stream crossings may be open-cut excavation, inverted siphon, bridge crossings or gravity boring under the streambed. Sewers crossing streams shall be constructed such that they are capable of absorbing pipe movement and joint deflection while remaining intact and watertight and free from changes in alignment or grade. Trench backfill material shall not readily erode, cause siltation, damage pipe during placement or cause chemical erosion to the pipe.

g. Erosion and Siltation. Construction methods that minimize siltation and erosion shall be employed. The design engineer shall include the construction methods to be employed for sewers in or near streams in the design plans and specifications.

h. Environmental. Obtaining an Army Corps of Engineers Section 404 permit is a separate activity and conformance with these design criteria does not relieve the Contractor/Owner of those requirements. Sewer lines shall be protected from stream scour and one hundred (100–yr) year flood velocities. Specifications must include cleanup, grading, seeding planting or restoring all work areas as soon as practicable.

2. Bridge Crossings.

a. Review and Approval. The Town of Windsor, The Colorado Department of Transportation, the specific Railroad Company, or County transportation divisions or other entities responsible for bridge design, should be contacted for proper design, construction, and any permits required for any sewer transmission line utilizing existing bridges for road and stream crossings. The Town Engineer shall first approve all requests, cases, and locations, prior to final design.

b. Flood Protection. Stream crossings utilizing the pipe as a bridge should have proper head wall designs, pipe elevation above the stream and guy anchors for protection from the one hundred (100–yr) year flood.

3. Siphons.

a. Review and Approval. Where possible, siphons should be avoided. If it can be demonstrated that a siphon is cost-effective and can be adequately maintained, the Town,

on a case-by-case basis, can consider such a system. All proposed siphons shall be designed by a Professional Engineer and shall require the review, approval, and written permission of the Town Engineer as well as other affected parties. The Town Engineer shall first approve all requests, cases, and locations, prior to final design.

b. Device. Where permitted, inverted siphons should not have less then two (2) barrels, with a minimum pipe size of six (6″) inches, and should be provided with necessary appurtenances for convenient flushing and maintenance; the manholes should have adequate clearance for rodding.

c. Design. In general, sufficient head should be provided and pipe sizes selected to secure velocities of al least three (3 fps) feet per second for average flows.

d. Maintenance. The inlet and outlet details should be arranged so that the normal flow is diverted to one (1) barrel so that either barrel may be taken out of service for cleaning.

4. Small Diameter Technology.

a. Review and Approval. Any proposed small diameter technology to provide sanitary sewage collection service shall be designed by a Professional Engineer and shall require the review, approval, and written permission of the Town Engineer as well as other affected parties. The Town Engineer shall first approve all requests, cases, and locations, prior to final design. Generally, the use of gravity sanitary sewer collection systems with wet well mounted package lift stations and force mains is the preferred selection.

b. Minimum Size. Where permitted, under special conditions, such as low tributary population, small diameter sewer technology may be considered. Small diameter technology may include pressure, vacuum and small diameter gravity sewers; however, service laterals should not be less than one and one quarter (1¼″) inches in diameter and sub-mains should not be less than two (2″) inches in diameter.

c. Slope. Where low tributary population utilizes small diameter sewer technology, a variable grade sewer is allowable. Proper location of cleanouts, pressure relief valves and manholes are required. A scheduled maintenance program to prevent clogging is required.

d. Cleanouts and Manholes. Sewers designed with small diameter technology may use cleanouts instead of manholes in certain instances. Manholes should still be used for proper maintenance and inspection of the system.

e. Operation and Maintenance. Operation and maintenance of the entire system shall be clearly addressed by the Design Engineer and the responsibility thereof identified prior to any final design review. The party designated as responsible for operation and maintenance shall require the review, approval, and written permission of the Town Engineer as well as other affected parties.

L. LIFT STATIONS AND FORCE MAINS

1. General.

a. Wastewater pumping stations (lift stations) will be considered only when gravity flow is not feasible or specified by the Town Engineer. Every effort shall be made in the design of the sewage collection system to minimize the need for lift stations.

b. Package pump stations with separate wet well, manufactured by Gorman Rupp, are the only standard accepted by the Town of Windsor.

c. The use of submersible sewage pumps or pneumatic ejectors is unacceptable.

2. Lift Station Location.

a. Flooding Damage. Sewage lift stations shall not be subject to damage by a one hundred (100-yr) year flood event. A suitable site, preferably located off the right-of-way of streets and alleys should be provided.

b. Accessibility and Security. Lift stations should be readily accessible to maintenance vehicles under all weather conditions. The facility shall be located off the travelled way. Security fencing and access hatches with locks shall be provided. Security fencing, of a type and height approved by the Town, shall encompass the entire perimeter of the lift station site.

c. Ownership. Lift stations shall be located on property deeded to the Town of Windsor. Property shall be adequately dimensioned to allow convenient access for repair, maintenance, and overhaul.

d. Spill Containment. Lift stations shall not be located in areas subject to environmental damage or where sewage spills cannot be contained.

3. General Lift Station Design Requirements.

a. Sewage lift station design shall provide for three hundred (300%) percent (one hundred (100%) percent from each of three (3) pumps) of firm (reserve) capacity of estimated peak flows.

b. At least three (3) pumps shall be provided in each lift station with each pump supplying one hundred (100%) percent backup capacity.

c. All lift stations shall have backup generation capable of providing at least enough electrical power to start and run one (1) pump (*i.e.* enough power to pump sewage at the estimated peak flow rate).

d. Wet well design shall include configuration, size, volumetric wet well capacity, level control switches, and alarm systems with telemetric capability.

e. Wet wells shall be designed with a protective coating to eliminate deterioration by hydrogen sulfide (H_2S).

f. Line storage shall not be used in sizing wet wells.

4. Force Mains.

a. At a minimum, the force main pipe material shall be AWWA C900, colored white, polyvinyl chloride (PVC) pipe.

b. The force main diameter and pipe material shall be selected by the Design Engineer for the specific situation.

c. Force Mains shall be designed such that, at design average flow, a cleansing velocity of at least two (2 fps) feet per second shall be maintained.

d. Vaults and blow off valves shall be installed at all “low points” in force mains.

e. Manually operated air relief valves (ARV) shall be installed in force mains at "high points".

f. Force mains shall enter the gravity sewer collection system at a point not more than one (1′) foot above the flowline of the receiving manhole

5. Report.

a. A basis of design or engineer's report shall be prepared and approved by the Town Engineer prior to approval of the Construction Drawings for the pump station and any associated development.

b. The report will include but is not limited to discussion on lift station design parameters, accessibility, pumps, force mains, housing structures, controls, valves, wet wells, buoyancy considerations, ventilation, flow measurement, power supply, alarm system, and odor control measures.

c. A final design submittal for a lift station shall include a final engineer's report, pertinent design calculations, Construction Drawings, and lift station specifications provided by the Design Engineer.

d. If a lift station building (housing structure) is required, the structure shall be designed by a licensed Architect in accordance with currently adopted land development and building codes and shall have appropriately sized and located hatches for future pump installation/removal. Building specific construction specifications (*i.e.* building materials, plumbing, electrical, telemetric, etc.) shall be provided by the Design Engineer or Architect.

e. Sewage lift station designs and reports shall meet the requirements detailed herein in **Section 1.09.**, **Sanitary Sewer Design**, **Lift Stations and Force Mains**.

6. Approvals.

a. The Town will require a basis of design to be submitted with the detailed plans and specifications for all lift stations. Discharging raw sewage into State waters is unacceptable under any circumstances.

b. Lift stations require site location and design review and approval from the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division (WQCD) and the regional 208 water quality planning agency, North Front Range Water Quality Planning Association (NFRWQPA).

c. Prior to WQCD final design review and approval, the lift station Site Application must be submitted to the NFRWQPA. Refer to NFRWQPA guidelines and requirements on the lift station site location and design approval process.

d. The Design Engineer shall bear the responsibility to carry the lift station project through the entire approval process and to obtain design/construction approvals from all appropriate entities.

7. Lift Station Startup.

a. The Contractor/Owner shall demonstrate the flawless operation of the lift station in manual and automatic mode prior to acceptance by the Town.

b. The startup operations shall demonstrate that the lift station and all components are completely functional including all valves, vents, controls, telemetering devices, and alarms.

c. A factory representative for the pumps and controls and generators shall be on site for the startup operation.

8. Lift Station Operation and Maintenance.

a. The Contractor/Owner shall supply the Town's Sewer Department with two (2) complete sets of shop drawings, pump curves, operation and maintenance instructions, including emergency procedures, maintenance procedures, tools and such spare parts as may be considered necessary.

b. Operation and maintenance instructions shall be specific to the equipment installed. All non-relevant reference material shall be removed or clearly crossed out using heavy red line.

c. All emergency power generation equipment should also be provided with operation and maintenance instructions requiring routine starting and running of such units at full load.

9. Warranty.

a. A two (2-yr) year warranty shall be provided for the lift station system including performance, materials, and installation.

b. The date of substantial completion shall be specifically determined, in writing, for the lift station system.

1.09 SANITARY SEWER LINE DESIGN

A. GENERAL

1. The purpose of this section is to provide information for the design and layout of a sanitary sewer collection system and lift stations with force mains. All sanitary sewer collection system designs shall be in accordance with the Town of Windsor Sewer Master Plan, latest revision, and these criteria.

2. This section is not intended to be inclusive of all situations and the Design Engineer may be required to use additional engineering judgment to meet the overall design intent for constructability and long-term operations and maintenance. This design criteria typically applies to sanitary sewer mains eighteen (18″) inches in diameter and smaller. The Town Engineer reserves the right to make final determinations of the system design based on the best interest of the Town's system.

3. This section specifies the minimum standards necessary for system analysis, layout, and design of sanitary sewer systems based on a hydraulic analysis using appropriate formulas and estimated wastewater flows. All sewer lines should be sized after the hydraulic analysis based on projected peak flows plus estimated infiltration/inflow.

4. Sanitary sewers are designed to convey the spent water supply of the community, industrial wastes, and unavoidable amounts of groundwater infiltration to a satisfactory point of treatment and disposal. All waters not containing impurities which are actually or potentially objectionable shall be excluded from the sanitary system. All designs and the construction of sanitary sewer collection systems **must** exclude rainwater contributions from roofs, streets, and other areas, including groundwater from foundation drains and other sources. These sources of extraneous waters shall not be accepted in the Town of Windsor sanitary sewer system.

5. The goal of the design of a sanitary sewer collection system is to provide for sufficient capacity to carry the peak-discharge with the pipe being no more than sixty (60%) percent full and be able to transport suspended material such that deposits in the sanitary sewer are precluded. It is essential that the sanitary sewer have capacity for the design sewage flow and adequate velocity at minimum sewage flow.

6. The goal of the design of a pumping (lift) station is to provide for redundant means of sufficient capacity to pump the peak-discharge of raw sewage from remote, low-lying areas through pressurized force mains to a satisfactory point of treatment and disposal. Discharging raw sewage to State waters is unacceptable under any circumstances, necessitating the design of lift stations and force mains to require repetitious means of pumping and emergency power equipment to be immediately available.

B. DESIGN CRITERIA

1. Estimated Sewage Flow.

    a. All pertinent information on the area to be served must be collected, including present or future land uses, consideration of upstream and offsite flow contributions, and potential groundwater conditions.
    b. Estimates of quantities of wastewater flows shall be based upon present and future populations, type of land use and the size of contributory area(s).
    c. Wastewater Flow Estimates. The wastewater flow estimates given in the following table are minimum criteria and the Town reserves the right to modify the criteria, at any time, for the design of specific projects.

Table 1.09.1
Residential Wastewater Flow Estimates (gpd)

ZONE	Units per Acre	Occupancy (People/Unit)	Average Day Wastewater Flow
E-1	1	2.76 persons	250 gpd/ac
RMU	6	2.76 persons	1490 gpd/ac
SF-1	6-7	2.76 persons	1600 gpd/ac
SF-2	7-9	2.76 persons	2100 gpd/ac
MF-1	16-18	2.76 persons	4200 gpd/ac
MF-2	29-31	2.76 persons	7450 gpd/ac

Average daily flow per capita = 90 gpd

d. For estimating Commercial and Industrial wastewater flows, the Design Engineer shall use an average daily flow rate of fifteen hundred (1500 gpd/ac) gallons per day per acre as a minimum.
e. If design flows differ from those given above, the Design Engineer shall submit backup data supporting the alternative design flows. If the number of users, type of establishment, or probable average daily sewage flow is known, alternative average daily flows may be considered.
f. All calculations used to establish the design flow shall be prepared by the Design Engineer and submitted to the Town Engineer for review and approval.
g. In addition to the quantity of average day sewage flow estimated using the criteria set forth in this section, the Design Engineer shall consider the nature of any wastes that are not ordinary domestic sewage; and the quantity and type of discharge of an unusual nature such as swimming pool drainage, cooling water, commercial boundaries, floor drains from auto repair garages, steam cleaning, commercial dairy, food processing or service, car washes, metal treating or plating operations, or other similar uses.
h. Peaking Factor. The average daily flow estimated from the above criteria shall then be adjusted using a peak factor to determine the peak flow. A domestic flow peak factor of three (3.0) may be used, or, using the following equation based on population, the peaking factor (R) is obtained from the service population in thousands (P):

$$R = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

2. Infiltration and Inflow (I/I).

a. Infiltration and inflow (I/I) is extraneous water flow that enters the sanitary sewer collection system.
b. Infiltration is water entering the sanitary sewer collection system from the ground through service connections, defective pipes, pipe joints, and manhole connections.
c. Inflow is water entering the sanitary sewer collection system from roof drains, underdrains, surface stormwater runoff, and natural drainage.
d. An allowance due to infiltration and inflow (I/I) of two hundred (200 gpd/in/mile) gallons per day per inch of inside diameter per mile of pipe, shall be added to the peak design wastewater flow.
e. I/I flows are not subject to a peaking factor.

3. Design Flow.

a. The daily peak flow is the product of the estimated daily wastewater flow times the peaking factor, plus any other extraneous known flows, such as downstream of a lift station force main the maximum pumping rate must also be included.
b. The wastewater design flow shall be the daily peak flow plus wet weather infiltration and inflow (I/I).

$$\mathbf{Q_p = Q_a * pk\ fctr + Q_e}$$

and,

$$\mathbf{Q_d = Q_p + I/I}$$

where: Q_a = average daily estimated flows
Q_e = extraneous known flows
Q_p = daily peak flow
Q_d = design flow.

4. Hydraulic Design.

a. Sanitary sewer pipe sizes used within the Town of Windsor shall be calculated to carry the design flow, as detailed above, with the pipe being no more than sixty (60%) percent full and be able to transport suspended material to preclude deposits in the sewer line.
b. Interceptor and/or trunk sewer lines may be designed to a maximum of eighty (80%) percent full. The percentage of pipe full shall be based on the ratio of the depth of flow (d) to the internal pipe diameter (D), or:

$$\mathbf{\%\ full = d/D}$$

c. All sewers shall be designed and constructed to give velocities, when flowing sixty (60%) percent of flow depth, of not less than two (2 fps) feet per second or more than ten (10 fps) feet per second based on the Manning approximation of the Kutter Formula, given as:

$$V = \frac{1.486}{n} * R^{\frac{2}{3}} * S^{\frac{1}{2}}$$

where: V = mean velocity in feet per second (fps)
n = Manning's coefficient of 0.013
R = hydraulic radius (A/P)
A = area of flow in square feet (ft^2)
P = wetted perimeter in feet (ft)
S = slope of pipe in feet per feet (ft/ft).

d. Use of other practical Manning's coefficient "n", may be permitted, if justified, on the basis of research and field data and when approved by the Town Engineer.
e. Supercritical flows are not permitted.
f. Flow in pipe shall be given by the formula:

$$\mathbf{Q = A*V}$$

where: Q = flow in cubic feet per second (cfs)
A = area of flow in square feet (ft^2)
V = mean velocity in feet per second (fps).

5. Sewer Line Size and Slope.

a. To prevent solids deposition, all sewers should be so designed and constructed as to transport average sewage flows at mean velocities of two (2fps) feet per second based on the above formulas and roughness factor.
b. The Town may require the design and installation of a sanitary sewer collection main larger than is needed or deeper than necessary to adequately service the proposed development due to potential upstream and offsite flow contributions or other future needs. Refer to **Section 1.03.C.**, **Oversizing Policy**, of these criteria for oversizing and reimbursement agreements.
c. In addition to the quantity of design flow generated from a project, the impact of the additional flow into the downstream sewer systems shall be investigated to ensure that adequate capacity is available, not only for the proposed project, but for all present users of the existing sanitary sewer systems.
d. Sewer line size and slope shall be chosen so that sanitary sewers have capacity for the design sewage flow and adequate velocity at minimum sewage flow.
e. All sewers shall be designed and constructed to give velocities, when flowing sixty (60%) percent of flow depth, of not less than two (2 fps) feet per second or more than ten (10 fps) feet per second.
f. The slope between manholes shall be uniform and consistent.
g. No sanitary sewer collection main shall be less than eight (8″) inches in diameter. No sanitary sewer service line shall be less than four (4″) inches in diameter.
h. All sanitary sewer collection mains shall be designed to convey estimated design flows at sixty (60%) percent depth.
i. The following table lists the minimum and maximum allowable slopes for wastewater sewer lines. The minimum slopes are based on a mean velocity of two (2 fps) feet per second, and the maximum slopes are based upon a velocity of ten (10 fps) feet per second:

Table 1.09.2
Minimum and Maximum Slopes for Sewer Lines

Pipe Diameter (inches)	Minimum Slope (percent)	Maximum Slope (percent)
Services		
4″	2.08%	15%
6″	1.04%	12%
Mains		
8″	0.40%	8.34%
10″	0.28%	6.20%
12″	0.22%	4.86%
15″	0.15%	3.61%
18″	0.12%	2.83%
21″	0.10%	2.30%
24″	0.10%	1.93%

Maximum slopes allowed need to be design checked To ensure velocity does not exceed ten (10 fps) feet per second for design peak flow.

j. Where velocities greater than ten (10 fps) feet per second are anticipated, special provisions shall be included in the design to prevent solids from separating and deterioration or displacement of the sewer line by erosion and shock.

C. SEWER SYSTEM DESIGN REPORT

An analysis for the sanitary sewer collection system for a given project shall be submitted by the Design Engineer, as a design report, to the Town Engineer for review and acceptance. The design report will be reviewed by the Town, along with the engineering construction drawings.

The objective of the design report is to assist the Design Engineer with designing a sanitary sewer collection system to adequately serve peak flow conditions while adhering to the design requirements set forth in these criteria. The design analysis report for the sanitary sewer collection system serves as a tool for demonstrating the necessary number of connection points to the existing system, system reliability, and required pipe sizing.

The written design report shall, at a minimum, include the following information:

1. Title Page

    a. Report Title.

    b. Project name and location.

    c. Name, address, and phone number of:

        i. Owner
        ii. Developer
        iii. Design Engineer that prepared the report.

    d. Report preparation date.

2. Engineer Certification Sheet

    a. The report shall be prepared by or under the direct supervision of a Professional Engineer, licensed to practice in the State of Colorado, possessing adequate experience in the design of sanitary sewer collection systems.

    b. The report shall contain a certification sheet indicating that the design was prepared under the direct supervision of the licensed engineer and shall contain his/her signature and registration stamp with date of certification.

3. Table of Contents

4. Project Description and Location

    a. Clearly state the location of the project with text identifying the location, nature of the proposed development and identification of proposed connection points to the Town's existing sanitary sewer collection system. Provide a site vicinity map specifying the project's geographical location and the project area in acres.

    b. The report shall clearly state the land use zoning, estimated number of residential lots or living units, commercial and/or industrial square footages, and any extraneous sewage flows that might be expected.

    c. Indicate if the project will be phased. Elaborate on the anticipated timing for each project phase and the phase's associated building and infrastructure construction.

d. For multifamily, commercial, or industrial developments, indicate probable estimated sewage flows for each use.

e. Identify the locations of all sanitary sewer collection line connection points to the existing systems.

f. Discuss and identify existing sanitary sewer collection lines and provide the pipe diameter, slope, pipe material, and year of installation and estimated capacity available.

5. Sewer Utility Plan

a. Provide an overall Sewer Utility Plan drawing with a general overview of the entire project including, but not limited to, streets (complete with names), alleys, lot and block numbers, all proposed and existing utilities on and within one hundred (100′) feet of the project site, all existing and proposed easements and rights-of-way on and adjacent to the project site, and proposed and existing sanitary sewer collection systems.

b. The entire project shall be shown on one (1) sheet unless the project is too large to show in sufficient detail. If the Sewer Utility Plan must be shown on more than one (1) sheet, provide a key map on each sheet to aid in drawing orientation and locating the sheet construction in relation to the overall project.

c. The Sewer Utility Plan drawing shall include, at a minimum, the following information:

i. Map Scale, North Arrow, Vicinity Map.

ii. Proposed and existing Easements and Rights-of-way.

iii. Proposed and existing sewer system layout; mains and appurtenances with sizes, flows, and capacities.

iv. Proposed point(s) of connection for sewer mains to the existing system(s). All existing sanitary sewer mains shall be labeled with the pipe diameter, slope, type of material, and year of installation.

v. Tributary area(s) and topographic contours at two (2′) foot intervals, minimum.

vi. Underlying land uses, zoning, and densities.

vii. Proposed project phasing for utilities and structures.

viii. Other existing and proposed utilities that might affect the proposed sewer system layout or performance.

ix. Any other information deemed necessary by the Design Engineer or the Town Engineer.

6. References and Appendices

a. Provide a separate page referencing all design criteria, resources, and software used in preparing the design study and report.

b. Provide appendices as necessary to include computer printouts, copies of estimated flow assumption data, and peaking factors.

7. Requirements and Assumptions

a. All equations used, estimated flow assumptions, peaking factors, calculations, and essential design requirements, parameters, and constraints utilized in the design of the sanitary sewer collection system shall be shown concisely.

b. Indicate the software package(s) and version used for the sewer system modeling.

c. Indicate in which Town of Windsor sanitary sewer collection basin the project is located. Discuss and identify needs for any special improvements, *e.g.* limited downstream capacities, upstream tributary areas, interceptor mains, or trunk mains, etc.

d. Document all calculations for estimated population, design flows, peaking factors, and any other necessary design calculations..

e. Show design flow calculations and determination of which condition (design flow or minimum flow for velocity) governs.

f. Discuss any deviation from these standards and criteria and provide justification for any proposed variances. All such variances must be approved by the Town Engineer prior to approval of the development.

8. Lift Station, Force Main and Other Systems.

a. If a lift station is proposed, provide justification and discuss why other alternatives to a lift station were not chosen. Clearly define the area to be served by the lift station and discuss how other areas may or may not be served by the proposed lift station.

b. If other non-traditional gravity sanitary sewer collection system designs are considered, discuss in detail the need, basis of design and details, for such items as siphons, small diameter technology, and stream crossings.

c. If underdrain systems are proposed as part of the sanitary sewer collection system, discuss the need, purpose, discharge points, permit status, etc.

9. Report Results

a. Provide a schematic layout of the sanitary sewer collection system showing and labeling the connections, pipe network, and flow contributing nodes as presented and analyzed for each sewer model scenario.

b. Design parameters and the critical conditions shall be shown on an overall plan of the study area. Under separate cover, the conditions shall be shown which isolates the critical condition.

c. Provide a table of pipe segments, inverts, depths, slopes, minimum and maximum design flow rates, minimum and maximum velocity, and maximum d/D.

10. Design Conclusions

a. Prepare text discussing the sewer analysis results for all scenarios.

b. Confirm and discuss that pipe velocity estimates, calculated using estimated flow conditions, have met specified criteria.

c. Discuss any sewer line oversizing required by the Town over and above what is necessary for the development's sewer needs.

d. For phased developments, discuss phased construction of the sanitary sewer collection system and confirm that sewer pipes are sized appropriately to meet the design flow with peak flow and infiltration/inflow demand, and velocity requirements during the interim conditions.

11. Copies

a. Provide a minimum of three (3) certified copies of the Design Report for review and approval by the Town Engineer.

b. The Town may require electronic copies be submitted.

D. LIFT STATIONS AND FORCE MAINS – DESIGN

1. General.

a. Wastewater pumping stations (lift stations) will be considered only when gravity flow is not feasible or specified by the Town Engineer. Every effort shall be made in the design of the sewage collection system to minimize the need for lift stations.

b. Package pump stations, with separate wet well, manufactured by Gorman Rupp, are the only standard acceptable to the Town of Windsor.

c. Sewage lift station designs and reports shall meet the requirements of this design section and those specifications detailed in **Section 1.08,**, **Sewer Appurtenances**, **Lift Stations and Force Mains**.

2. Design.

a. Basis of Design. A basis of design for all wastewater pumping (lift) stations shall be prepared and submitted to assist the Town in reviewing the project design, plans, and specifications. The basis of design shall include, but not necessarily be limited to, the following:

i. Analysis of contributing areas to establish average and peak flow calculations for present and design conditions.
ii. Pump and motor design analysis to determine number, size, pump curves, and discharge parameters.
iii. Wet well configuration and size.
iv. Head loss calculations for force main design.
v. Buoyancy calculations where required.
vi. Lift station power requirements.
vii. Site design considerations.

b. Type. Package pump stations, manufactured by Gorman Rupp, are the Town's only standard acceptable to the Town of Windsor.

c. Structures.

i. In lift station design, wet and dry wells, including their superstructure, should be completely separated. Common walls must be gas tight.
ii. All lift stations shall include suitable equipment and access for the removal of pumps, motors and valves.
iii. Suitable and safe means of access shall be provided to all areas of the station including dry wells of lift stations and wet wells containing either bar screens or

other mechanical equipment requiring inspection or maintenance. Ventilation is required in both types of wells. Stairways are preferred over ladders for access.

iv. Housing for pumping equipment and controls shall be readily accessible and weather proof.

v. Where wastewater must be pumped prior to grit removal, the wet well and the discharge piping shall be designed to prevent grit accumulation.

vi. Where high groundwater conditions are anticipated, buoyancy of the lift station system shall be considered with adequate protections provided.

vii. Provision must be made for emergency storage of raw sewage or portable pumping in the event of an extended power outage or electrical or mechanical failure. Discharge structures are prohibited. An emergency storage structure and an alternate power source could be required for a proposed lift station. Consideration of this determination will be given to the proximity of the pumping station to surface waters and the designated use of such surface waters including immediate downstream users and the alarm systems installed, emergency response procedures, and response time of the Town's Sewer Department to an emergency.

d. Pumps.

i. At least three (3) pumps shall be provided and they shall have the same capacity. Each pump shall be capable of handling flows in excess of the expected maximum flow. Where three (3) or more pumps are provided, they should be designed to fit actual flow conditions and shall be of such capacity that with any one (1) pump out of service, the remaining pumps have capacity to handle the design peak hourly wastewater flows. The pump sizing should allow for a flow velocity of at least two (2 fps) feet per second in the force main.

ii. Pumps shall be capable of passing spheres of at least three (3″) inches in diameter unless other equipment is provided to prohibit such solids from entering the suction side of the pump. Readily accessible screens with clear openings selected to protect the pumps should precede pumps handling raw wastewater, special devices such as comminutors are installed to protect the pumps from clogging or damage. Convenient facilities shall be provided for handling screenings.

iii. Pump suction and discharge openings shall be at least four (4″) inches in diameter. Pumps shall be non-clogging type.

iv. The pump shall be so placed that under normal operating conditions, it will operate under a positive suction head. The Net Positive Suction Head (NPSH) and suction lift requirements of the pumps shall be considered.

v. Each pump shall have an individual intake. Wet well design shall be such as to avoid turbulence near the intake and cavitations in the pump.

vi. A separate sump pump shall be provided in dry wells to remove leakage or drainage with the discharge to the wet well above the overflow level of the wet well. Water ejectors connected to a potable water supply is prohibited. All floor and walkway surfaces shall have an adequate slope to the drainage point.

vii. The pumps and controls of pumping lift stations may be required to operate at varying delivery rates to permit discharging wastewater from the lift station to the treatment works at approximately the rate of delivery to the lift station. The hydraulic constraints of downstream treatment works must be considered for peak pumping rates to prevent overloading.

e. Electrical.

i. Electrical equipment in enclosed places where gas may accumulate, shall comply with the latest National Fire Protection Association (NFPA) Codes or the latest National Board of Fire Underwriters' specifications for hazardous

locations or submersible locations. All electrical enclosures shall be NEMA Type 4.

ii. Electrical equipment for each pump motor shall contain a six (6) digit (hours and tenths) non-resettable elapsed time meter.

iii. The electrical controls shall provide for automatic alternating of pumps and startup of lag pump if necessary due to influent flows.

iv. An adequate number of fluorescent light fixtures with guard shall be mounted in the equipment chamber to provide ample illumination for all areas within the chamber. A manual switch shall be conveniently located near the equipment chamber access point to control the light fixture.

v. A minimum of three (3), one hundred fifteen (115 v) volt outlets, with appropriate NEMA protection, shall be provided.

vi. A heavy-duty electric heater with automatic thermostat control shall be supplied. The heater shall be permanently mounted above the floor. Power and wattage requirements shall be as determined by the Engineer.

vii. A yard light shall be installed at each lift station site sufficient to adequately illuminate the area.

viii. All lift stations shall have a cathodic protection system designed and installed.

f. Controls.

i. Recessed and above grade, lift stations shall utilize a bubbler pump control system with a totally independent float control backup system.

ii. Liquid level controller activators should be located so that they will not be affected by flows entering the wet well or by the suction of the pumps.

iii. Float tubes in dry wells shall extend high enough to prevent overflow.

iv. The telemetric instrumentation shall include, but not be limited to: 1) high level wet well; 2) generator failure; 3) lift station flooding; 4) pump failure; and 5) Microtel automatic telephone dialer.

v. SCADA requirements shall be as directed by the Town's Sewer Department.

g. Valves.

i. Suitable shutoff valves shall be placed on suction and discharge lines of each pump.

ii. A check valve or pump control valve shall be placed on each discharge line, between the shutoff valve and the pump.

h. Ventilation.

i. Adequate ventilation shall be provided for all lift stations to mechanically ventilate the dry well.

ii. An automatically operated ventilating blower shall be provided, capable of delivering thirty (30) air exchanges per hour with the discharge going to the atmosphere.

iii. Dry well pits over fifteen (15′) feet deep shall have multiple ventilation inlets and outlets.

iv. Dampers should not be used on exhaust or fresh air ducts, and fine screens or other obstructions in the air duct should be avoided to prevent clogging.

v. Switches for operation of ventilation equipment should be marked and located conveniently. Consideration should be given to automatic controls where intermittent operation is practiced.

vi. There shall be no interconnection between the wet well and dry well ventilating systems.

i. Flow Measurement.

i. All pumping stations should have suitable devices for measuring, recording and totaling sewage flow and power consumption.
ii. For maintenance purposes, chart recorders shall be required.
iii. For billing or other purposes, as determined by the Town's Sewer Department, other types of recorders may be required.

j. Site Considerations.

i. A one (1″) inch potable water service water supply with a freeze-proof yard hydrant shall be provided at the lift station site.
ii. There shall be no physical connection between any potable water supply and a sewage pumping station, which under any conditions might cause contamination of the potable water supply.
iii. The lift station site shall be enclosed with security fencing, of a type and height approved by the Town, with a sliding gate having a minimum opening width of twelve (12′) feet.
iv. Adequate illumination provide from a yard light,
v. Entire enclosed area shall be graded with a crushed gravel surface, a minimum of eight (8″) inches thickness.
vi. At a minimum, the spare parts that shall be provided for each lift station include one (1) pump shaft seal. Provide standard steel shelving, as approved by the Sewer Department, sufficient to store spare parts and tools.

k. Alarm System.

i. Alarm systems shall be provided on all lift stations with an autodialer and shall be telemetered over a dedicated radio wave to the Town's Sewer Department.
ii. Alarm systems shall be activated in cases of power failure, pump failure, high water, or any cause of lift station malfunction including those previously listed.
iii. The Town's Engineering Department and Sewer Department shall review and accept alarm plans prior to installation.
iv. The Town shall determine, on a case by case basis, if the installation of an audiovisual device (*i.e*. horn or light) shall be required at the lift station site for external observation.

l. Power Supply.

i. All lift stations shall have backup generation capable of providing at least enough electrical power to start and run one (1) pump (*i.e.* enough power to pump sewage at the estimated peak flow rate).
ii. An emergency generator installation shall include the following at a minimum:

A. A Caterpillar Olympian (or approved equivalent) generator, enclosure, controls, transfer switch, and battery charger. Six (6) sets of keys shall be supplied to the Town at the time of startup.
B. Generators shall be placed on a six (6″) inch concrete pad sufficient in size to permit access and maintenance.
C. The transfer switch shall be supplied with a programmable exerciser.
D. The system shall be supplied with a battery warmer.
E. The generator shall be supplied with a block heater.
F. The generator shall be fueled by natural gas, which shall be supplied to the site as part of the project. Diesel power may be considered on a case by case basis as determined by the Town Engineer.
G. The system shall be supplied with a four (4) plex, one hundred ten (110V) volt exterior outlet within the generator enclosure.

H. The need for automatic starting of emergency power equipment shall be required.

3. Wet Well Design.

a. Capacity. The effective capacity of the wet well should provide a holding period not to exceed thirty (30 min) minutes for the design minimum flow. Smaller wet wells may be considered when utilizing variable capacity pumping systems. For large peak flow ratios, extended pumping ranges or extended holding times will be considered.

b. Size. Volumetric wet well capacity shall be determined by the following formula:

$$t = \frac{V}{P - F} + \frac{V}{F}$$

Where: t = Length of time between pump starts (five (5) minutes minimum).
P = Pump capacity in gallons per minute (gpm).
V = Wet well capacity between lead pump start and lead pump stop.
F = Inflow rate in gallons per minute (gpm).

c. Fillets. Concrete fillets at an angle of sixty (60°) degrees up from horizontal shall be included in the wet well to channel solids to the pump intake. The volume of the fillets shall be accounted for in the wet well capacity. The weight of the fillets may be used in buoyancy calculations.

d. Level Control. Level control switches in the wet well shall be set as follows unless otherwise approved:

i. The high level alarm shall be at least one half (½′) foot below the invert of the lowest inflow pipe.
ii. The high level "pump on" switch shall be at least one half (½′) foot below the high level alarm.
iii. The low level "pump on" switch shall be at least one half (½′) foot below the high level "pump on" switch.
iv. The high level and low level "pump off" switch shall be set a sufficient distance below the low level "pump on" switch that the volume required as described herein in this section is met.
v. The "pump off" switch shall be at least one (1′) foot above the bottom of the pump intake.
vi. The pump intake shall be a minimum of one half (½′) foot above the bottom of the wet well.

e. Divided Wells. Where continuous pump station operation is required, consideration should be given to dividing the wet well into two (2) sections, properly interconnected, to facilitate repairs and cleaning.

f. Floor Slope. The wet well floor should have a minimum slope of one to one (1:1) to the hopper bottom. The horizontal area of the hopper bottom should be no greater than necessary for proper installation and function of the pump inlet.

g. Ventilation. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, it shall be mechanically ventilated. Where mechanical ventilation of the wet well is required, it should be continuous and should provide at least twelve (12) complete air changes per hour. For intermittent operation, at least thirty (30) complete air changes per hour should be provided.

h. "Confined Space". All wet wells shall contain a placard within the wet well marked "CONFINED SPACE". The location, dimensions, and other details shall meet OSHA requirements.

i. Groundwater Protection. Both the wet well and the dry well shall be properly protected from groundwater intrusion with a water-proof coating prior to backfilling.

4. Force Main Design.

a. System head calculations shall include the size and length of force mains and assumed friction factor.

b. Force mains shall be designed such that, at design average flow, a cleansing velocity of at least two (2 fps) feet per second shall be maintained.

c. The force main(s) shall be provided with a connection point within the pump station enclosure for emergency operation using a portable pump. The connection shall consist of a wye on the force main and a riser with a six (6″) inch flange with blind cover set in a meter pit.

5. Report.

a. A design analysis for the entire lift station system for a given project shall be submitted by the Design Engineer, as a report, to the Town Engineer, and other required entities, for review and acceptance. The report will be reviewed by the Town, along with the engineering construction drawings.

b. The objective of the lift station analysis report is to assist the Design Engineer with designing a project's wastewater pumping station system to adequately serve peak, average, and minimum demands while adhering to the design requirements set forth in these criteria. The lift station analysis report for the project serves as a tool for analyzing adequacy of design and future maintenance or operation concerns.

c. For wastewater pumping (lift) stations, the engineering report shall include information regarding the contributory areas, basis of design, pertinent information detailed above in this section, and other essential features.

d. A plan shall be submitted for the project involving new construction or revision of an existing wastewater pumping station showing the location and extent of the tributary area, any municipal boundaries within the tributary area, the location of the lift station and force main and pertinent elevations.

e. Design considerations should include lift station size, type of construction, pump and motor selection, system design, controls, valves, piping, access and pumping efficiency.

f. The report shall incorporate the basis of design and shall include, but not necessarily be limited to, the following:

i. A narrative section describing the project location, the area served by the lift station, the design parameters used in the design of the lift station, the general components of the station and a description of the discharge point and conveyance to the discharge point.
ii. Minimum, average and peak flow calculations for present and design conditions.
iii. Wet well configuration and size.

iv. Number, type, capacity, motor horsepower and Net Positive Suction Head (NPSH) requirements of proposed pumping units. Motors shall be protected from over current, over temperature, and voltage imbalance.
v. System head curve and head computations for design conditions of the pumping system for all phases of development.
vi. System head calculations shall include the loss due to the size and length of force mains (and the assumed design friction factor), all dynamic losses, all bend losses, expansion losses, any losses within the pumping system, and the static pumping head.
vii. A pump curve(s) for the selected pump(s).
viii. Calculations showing flotation/buoyancy potential and proper ballasting.
ix. Description of primary and backup power sources.
x. Station size, type of construction, pump and motor selection, system design, controls, valves, piping, access, and efficiency.
xi. A completed CDPHE application for site approval for construction of the lift station.
xii. Specifications for all lift station components including, but not limited to, the lift station itself and the backup generator and its control system and the telemetric equipment.

g. Detailed Plans shall be submitted showing the following, where applicable:

i. A contour map of the site at two (2′) foot intervals.
ii. Proposed lift station, including provisions for installation of future pumps or ejectors.
iii. Existing lift station, if applicable.
iv. Elevation of high water at the site for the one hundred (100-yr) year flood event.
v. Maximum elevation of wastewater in the collection system and wet well in the event of a power failure for the estimated duration of power outage.
vi. Detailed electrical and control system plans.
vii. Detailed plans for the future force main, including plan and profile drawings.
viii. Test borings and groundwater elevations.
ix. A plan of operation and sequence of events for continuous and safe transfer of wastewater during the construction.

1.10 EASEMENTS

A. GENERAL

When it is not feasible for potable waterline or sanitary sewer line installation to be in a dedicated street right-of-way, the installation shall be made within a dedicated easement. The conditions for allowance of such an exception shall be determined for each individual case. Easements, when dedicated by a Final Plat, shall be designated as Public Utility Easements, exclusively for the Town's Water/Sewer System. Alternately, easements conveyed by separate instrument shall be dedicated by separate document and recorded prior to the Town's acceptance of the Construction Drawings. Widths of easements shall be as follows:

1. For a dedicated potable waterline or non-potable irrigation main or sewer line easement containing just one (1) main, the width shall be twenty (20′) feet or twice the depth to the invert of the pipe, whichever is greater.

2. For a combined potable waterline and sanitary sewer line easement, the total width shall be thirty (30′) feet or twice the maximum depth to the invert of the potable waterline plus twice the maximum depth to the invert of the sanitary sewer pipe, whichever is greater.

3. Easements containing more than one (1) wastewater main shall be increased by an additional ten (10′) feet for each additional main. Depending on depth of main, additional easement width may be required.

4. Combined easement widths are required to be wider than the widths previously stated if non-potable irrigation mains are to be included in the easement or if any line depth requires additional width to be able to safely excavate around the pipe without the use of a trench box.

B. DESIGN CRITERIA

1. Waterlines or sewer lines within easements shall be located a minimum ten (10′) feet from the edge of the easement or equal to the depth to the pipe invert, whichever is greater.

2. In no case shall a main or related appurtenance be located closer than ten (10′) feet to the nearest easement, tract or private property line.

3. There shall be no detention ponds, berms greater than three (3′) feet in height, permanent structures, fences, trees, shrubs with mature height greater than three (3′) feet, or other obstructions that will impede the ability of the Town to adequately maintain and service the waterline(s)/sewer line(s) located within the easement.

END OF SECTION

TOWN OF WINDSOR

DIVISION II

WATER DISTRIBUTION SYSTEMS

SANITARY SEWER COLLECTION SYSTEMS

WATERLINE & SEWER LINE CONSTRUCTION SPECIFICATIONS

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SECTION 01010

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SCOPE

A. General. All potable waterline and sanitary sewer collection system construction within the Town of Windsor, in Town rights-of-way, dedicated easements, or on Town owned property shall be constructed in accordance with the requirements of these specifications, Colorado Department of Transportation Standard Specifications for Road and Bridge Construction as referenced herein, and as related to Town Ordinances. All standard specifications, *i.e.* AWWA, ASTM, ACI, ISSA etc. are made a portion of these specifications by reference and shall be the latest edition and revision thereof. The Town of Windsor standards, specifications, and special provisions shall take precedence over conflicting provisions in the CDOT Standard Specifications and other referenced standards.

Whenever the provisions of these Standards are found to be inconsistent with any other regulations or codes, the Engineer (as defined below) shall determine the standard to apply. The provisions of these regulations are minimum requirements that do not preclude imposition of more restrictive standards by agreement or by law.

B. Purpose. The purpose of this Design Criteria and Construction Specifications, Division II, Water and Sewer Systems document is to provide the Town of Windsor's construction standards for the use of Owners, Department of Public Works, Developers, Design Engineers, and Contractors as criteria for the design and construction of water mains, services, and appurtenances and sewer mains, services, and appurtenances.

C. Accepted Plans. All waterline and sewer line construction shall be performed in accordance with engineered construction plans for the work, prepared under the direction of a Professional Engineer and approved by the Town of Windsor Engineering Department and/or Water or Sewer Department. Plans shall conform to the Design Criteria section of these specifications and shall show all the information called for. Construction shall conform to the Standard Detail drawings of the Town of Windsor.

Prior to the Contractor/Owner beginning work, an accepted set of plans and specifications must be on file with the Town of Windsor Engineering Department. All contracts, bonds, insurance, permits, and licenses must be fully executed by the Contractor/Owner before beginning work. Contractor/Owner shall have a copy of the approved plans and specifications, along with the Town's "Water Distribution System and Sanitary Sewer Collection System Design Criteria and Construction Specifications", on the site at all times during construction.

D. Preconstruction Conference. A preconstruction conference shall be held prior to the issuance of any permits for construction. Call 970-674-2400 to arrange a preconstruction conference. Attendance should include representatives from the Town's Engineering Department, the Town's Water and/or Sewer Department, Developer/Owner, Design Engineer, General Contractor and Subcontractors including earthwork, utilities, waterline and sewer line construction, etc.

1.2 GENERAL CONDITIONS

A. **DEFINITIONS**

In addition to the definitions given in **Section 1**, **MINIMUM DESIGN CRITERIA**, **1.02.B**, wherever the following words, phrases, or abbreviations appear in these specifications they shall have the following definition and meaning:

1. ABILITY – that which a person can do on the basis of present development and training.

2. AGENCY – shall mean the Town of Windsor.

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3. CDOT STANDARD SPECIFICATIONS – Colorado Department of Transportation, "Standard Specifications for Road and Bridge Construction" latest edition.

4. CERTIFICATE OF FINAL ACCEPTANCE – at the expiration date of the warranty period and after all deficiencies are corrected to the satisfaction of the Town Engineer, a Certificate of Final Acceptance will be issued.

5. COMPETENT – a person who has the natural powers, physical or mental, to meet the demands of a situation or work; the word is widely used to describe the ability to meet all requirements, natural, legal, or other of a given task.

6. CONSTRUCTION ACCEPTANCE – upon receipt of a letter requesting construction acceptance from the Town Planning Department, and based upon the recommendation of the Town Engineer, a letter shall be issued accepting the improvements, beginning the required warranty period.

7. CONSTRUCTION DRAWINGS – detailed and working drawings, including plan, profile, and detail sheets of proposed utility, drainage, and street and sewer line and/or waterline improvements, approved by the Town Engineer which graphically shows the scope, extent, and character of the Work to be performed by the Contractor.

8. CONSULTANT – the partnership, corporation, or individual who is a Registered Professional Engineer in the State of Colorado, hired by the Developer/Owner and is empowered to act as his agent for the project.

9. CONTRACTOR – the corporation, association, partnership, or individual who has entered into an Agreement with the Owner to perform the work, and who is licensed and bonded in the Town of Windsor in accordance with the requirements of the Town Code, for waterline and/or sewer line construction work, within the public right-of-way.

10. DAYS – intended as calendar days, not normal working days, unless stipulated as working days.

11. DESIGN ENGINEER – the partnership, corporation, or individual who is registered as a professional engineer, according to Colorado statutes, and who is hired by the Owner, and is empowered to act as his agent for the project.

12. DIVISION – when referred to in the CDOT Standard Specifications shall mean the Town of Windsor Engineering Department.

13. ENGINEER – a term used in situations where a decision or action may be required by the Town Engineer of the Town of Windsor, or his designated representative.

14. HYDRAULIC RADIUS – the cross sectional area of a stream of water divided by the length of that part of its periphery in contact with its containing conduit; the ratio of area to wetted perimeter.

15. INFILTRATION/INFLOW (I/I) – the extraneous water flow that enters the sanitary sewer collection system

16. INVERT – the lowest point of the internal cross section of a pipe, culvert, manhole, or sewer.

17. INSPECTOR – an authorized representative of the Town Engineer, assigned to make inspections to assure Work is completed in compliance with plans, standards, and specifications.

18. LIFT – the maximum specified thickness of material that may be placed at one time.

19. MAY – a permissive condition. No requirement for design or application is intended.

20. NORMAL WORKING DAYS – Monday through Friday. Saturdays, Sundays, and legal Holidays shall not be considered normal working days.

21. OR AN APPROVED EQUAL – as approved to being acceptable by the Engineer.

22. OWNER – the developer, corporation, association, partnership, or individual who has entered into an Agreement with the Town and has entered into an agreement with the Contractor to perform the work.

23. PROJECT AS BUILT RECORD DRAWINGS (aka "AS-BILTS") – detailed drawings which have been prepared by the Design Engineer, upon completion of construction of improvements, and show actual construction and contain field dimensions, elevations, details, locations, changes made to the construction drawings by modification, details which were not included on the construction drawings, and horizontal and vertical locations of underground utilities which have been impacted by the utility installation.

24. PROJECT REPRESENTATIVE – shall mean an authorized representative of the Engineer assigned to complete project observation and review for contract performances, standards, and contract compliance.

25. PROVIDE – furnish and install complete in place.

26. QUALIFIED – acquired abilities: skill, knowledge, experience, that fits a person for a position, office, or profession.

27. REMOVE – remove and dispose of legally.

28. RIGHT-OF-WAY (ROW) – all streets, highways, avenues, lanes, alleys, courts, places, square, curbs, sidewalks, easements, or other public ways in the Town of Windsor which have been or may hereafter be dedicated and opened for public use, or such other public property so designated in any law of this State.

29. SEWER SERVICE LINE – all pipes, fittings, wyes, risers, plugs, and appurtenances for conveying wastewater from the building premises to the sanitary sewer main.

30. SHALL – a mandatory condition.

31. SHOULD – an advisory condition. Where the word "should" is used, it is considered to be advisable usage, but not mandatory. Deviations may be allowed when reasons are given which show that the intent of the standard is met.

32. SIPHON – a conduit or culvert with a U or V shaped grade line to permit it to pass under an intersecting roadway, stream or other obstruction.

33. STANDARD STREET SPECIFICATIONS – the current Town of Windsor, Division I, Design Criteria and Construction Specifications for Streets.

34. STANDARD WATERLINE AND SEWER LINE SPECIFICATIONS – the current Town of Windsor, Division II, Design Criteria and Construction Specifications for Water Distribution Systems and Sanitary Sewer Collection Systems.

35. STREET – as used in this specification shall include the pavement section, right-of-way, sidewalks, driveways, bikeways, alleys and alley approaches.

36. SUBGRADE – the bed of ground or lowest level of a roadway section upon which the subbase is placed to enable the pavement structure, shoulders, and/or curbs and sidewalks to be constructed.

37. TAP – the physical connection to the water distribution main and/or sanitary sewer collection main.

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38. TESTING – shall mean tests that shall be performed by a qualified testing firm, for the Town of Windsor Engineering Department, to verify compliance with these specifications. Acceptance tests shall include but not be limited to the following: CONCRETE - slump, compressive strength, air content, and aggregate sieve analysis tests; SOILS -moisture density relationship and density tests; WATER – bacteriological quality, hydrostatic, and leakage tests; SEWER- air, vacuum, alignment, and video inspection tests.

39. TOWN – The Town of Windsor, Colorado, or an individual employed by the Town of Windsor whom is authorized to make the applicable decisions on behalf of the Town.

40. UTILITIES – shall mean all utilities on site prior to the time of any design; such as but not limited to water lines, sanitary sewer lines, drainage lines, electric lines, gas lines, telephone lines, and cable television lines.

41. WATER SERVICE LINE – all pipes, fittings, corporation stops, curb stops, and appurtenances for conveying water from the distribution main to the premises and/or meter as applicable.

42. WETTED PERIMETER – the length of the wetted contact between the water prism and the containing conduit, (measured along a plane at right angles to the conduit).

43. WORK – the entire completed construction or the various separately identifiable parts required to be furnished for the project. Work is the result of performing services, furnishing the labor and furnishing and incorporating materials and equipment into the construction.

44. WORKING DAYS – any day, exclusive of Saturdays, Sundays, and holidays, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed with the normal working force engaged in performing those items controlling the completion of the work.

45. WORKING HOURS – the Contractor shall restrict working hours to between 7:00 a.m. and 6:00 p.m. on normal Town of Windsor business days unless prior approval has been obtained from the Town Engineer.

46. WYE – the sewer service connection fitting installed in conjunction with the sanitary sewer collection main.

B. **ABBREVIATIONS**

1. AASHTO – American Association of State Highway and Transportation Officials.

2. AC-FT – Acre-feet.

3. ACI – American Concrete Institute.

4. ADA – Americans with Disabilities Act.

5. ANSI – American National Standards Institute.

6. APWA – American Public Works Association.

7. ARV – Air release valve.

8. ASTM – American Society for Testing and Materials.

9. AVV – Air vacuum valve.

10. AWG – American Wire Gauge.

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11. AWWA – American Water Works Association.
12. CAV – Combination air valve.
13. CDOT – Colorado Department of Transportation.
14. CDPHE – Colorado Department of Public Health and Environment.
15. CFS – Cubic feet per second.
16. CMP – Corrugated Metal Pipe.
17. CRS – Colorado Revised Statues.
18. DIP – Ductile Iron Pipe.
19. DR – Dimension Ratio (pipe outside diameter over minimum pipe wall thickness).
20. EPA – United States Environmental Protection Agency.
21. FEMA – Federal Emergency Management Agency.
22. FPS – Feet per second.
23. FT^2 – Square feet
24. GPCD – Gallons per capita per day.
25. GPD – Gallons per day.
26. GPD/AC – Gallons per day per acre.
27. GPM – Gallons per minute.
28. ID – Inside diameter.
29. MJ – Mechanical joint.
30. MUTCD – Manual on Uniform Traffic Control Devices.
31. NEC – National Electrical Code.
32. NEMA – National Electrical Manufacturers' Association.
33. NFRWQPA – North Front Range Water Quality Planning Association (Regional 208 Agency).
34. NSF – National Sanitation Foundation.
35. OD – Outside diameter.
36. OSHA – Occupational Safety and Health Administration.
37. PRV – Pressure Reducing Valve.
38. PSI – Pounds per square inch.
39. PSIG – Pounds per square inch gauge.

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40. PVC – Polyvinyl Chloride (pipe).

41. RCP – Reinforced concrete pipe.

42. SDR – Standard Dimension Ratio (pipe outside diameter over minimum pipe wall thickness).

43. UNCC – Utility Notification Center of Colorado.

44. WQCD – Water Quality Control Division of CDPHE.

45. W-SFPD – Windsor-Severance Fire Protection District.

C. **INTERPRETATIONS**

1. These Specifications contain many command sentences which are directed at the Contractor/Owner unless otherwise stated.

2. These Specifications are intended to be sufficiently detailed to provide adequate definition of the work to be performed and to insure the quality of that work. The Contractor/Owner, or his representative, shall be responsible for understanding the provisions and the content of these Specifications.

3. The Contractor/Owner shall request clarification of all apparent conflicts by contacting the Engineer. The Engineer will not be responsible for any explanations, interpretations, or supplementary data provided by others.

D. **VARIANCES FROM STANDARDS**

These standards and construction plans are intended to supplement each other. When conflicts and/or questions arise between the accepted plans, specifications, development standards, referenced standards or other contract documents, the Town Engineer shall make the final decision concerning such matters. If administrative changes are made after approval of the plans, the variance from these standards must be approved in writing by the Engineer. Work shall be completed according to the design accepted by the Town. Written clarification shall be obtained from the Engineer for acceptance of omissions, conflicts, or revisions prior to construction.

E. **OMISSIONS**

1. Any work not specifically set forth in the construction plans or these standards, but which is necessary as determined by the Engineer, shall be completed.

2. The Standards and Specifications are complementary; what is called for by one is as binding as if called for by all. It is the intent of the Standards and Specifications to require a functionally complete Project (or part thereof) to be constructed in accordance with these Standards and Specifications. Any work, materials, or equipment that may reasonably be inferred as being required to produce the intended result will be provided whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe work, materials, or equipment, such words shall be interpreted in accordance with that meaning.

F. **GENERAL QUALIFICATIONS**

The provisions of the Standards and Specifications apply to the construction, enlargement, removal, alteration, relocation, repair, trenching, and restoration of any Public Improvement or common facilities regulated herein.

1. Exceptions. Requests for exceptions shall be submitted in writing to the Town's Engineering Department. The request shall state the variance requested, the justification and supporting data for

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the variance, and the requested change to the standards or specifications for the specific project. The Engineer may require that exceptions be signed by a professional engineer registered to do work in the State of Colorado and bear their seal.

2. Criteria. Exceptions to the Construction Specifications for Waterlines and Sewer lines as outlined in this document shall be reviewed by the Town Engineer, or his designee, and shall meet the following criteria for approval:

   a. Special circumstances or conditions exist which limit the ability of the design to meet the design standards outlined in the document. Financial difficulties, loss of prospective profits, and previously approved exceptions in other developments shall not be considered special circumstances; or

   b. The exception represents an alternative design that will meet the intent of the standards and requirements set forth in this document.

   c. In either case, if granted, the exception will not be detrimental to the public interest or other property, nor in conflict with the Town's Comprehensive or Master Plans, and will not endanger the public safety, health, or welfare.

3. Approval. All exceptions for construction specifications must be reviewed and acted on prior to construction. The Town shall respond promptly and in writing to such requests but reserves a minimum of five (5) working days for review and response. When additional review time is required, the Town shall notify the submitter of the need for additional time within two (2) working days of the submittal.

1.3 REGULATIONS FOR WATERLINE AND SEWER LINE CONSTRUCTION

A. LICENSES AND PERMITS REQUIRED

1. Permit. All waterline and sewer line construction, including appurtenances and required cuts and fill in Town rights-of-way shall be done by a licensed and bonded contractor as provided for in the Town of Windsor's Municipal Code. In addition to entering into any required development agreement with the Town, no person, firm, or corporation may perform any work on the Town's Water Distribution System or Sanitary Sewer Collection System or within the public right-of-way without first obtaining the appropriate permit through the Engineering Department, unless specifically waived by the Town Engineer. Once the permit is secured, the permittee shall notify the Town's Engineering Department and Water Department twenty four (24) hours prior to initiating construction.

   Every applicant shall agree in making application for a permit to be bound by all provisions of the Town of Windsor's Municipal Code. The following is required to complete a construction permit:

   a. 8 ½" x 11" Site Plan
   b. Signed and accepted construction plans
   c. Project Schedule and Quantities

   A Traffic Control Plan, Certificate of Insurance, and cover sheet must be submitted and reviewed by the Town Engineer before permit for excavation or construction will be issued.

   A permit for excavation or construction in public right-of-way/easement is required for the following. (See Appendix)

   a. Waterline Construction. Any new waterline construction, reconstruction, connections, and repairs.
   b. Sewerline Construction. Any new sewerline construction, reconstruction, connections, and repairs.

c. Utility Construction. Any new, reconstruction, expansion, and repair of water, sewer, storm sewer, power, gas, telephone, and cable TV lines and other various appurtenances related to these projects in the public right-of-way/easements. This permit also covers Emergency Waterline repairs.

2. Other Fees and Permits. The Contractor/Owner shall obtain all necessary permits for construction, unless otherwise directed by the Town Engineer. All permits must be in accordance with Town, County, State, and Federal requirements. Town review and approval of all permits must be accomplished prior to the start of any construction. Examples of permits that might be required and locations where initial contact is to be made are as follows:

Partial List of Permits	Initial Contact
State's Utility Permit	CDOT
State's Access Permit	CDOT
Railroad Use of Right-of-Way	Railroad Company
Railroad Work in Right-of-Way	Railroad Company
E.P.A. N.P.D.E.S. Permit	Colorado Dept. of Health
Corps of Engineer's Permits	Corps of Engineers
Air Quality	Weld and/or Larimer County
Work in Ditch Right-of-Way	Individual Ditch Companies

This list is provided as an aid, and shall not be interpreted as a complete list of all permits required. It shall be the responsibility of the Contractor/Utility to determine the type of permits required by the specific development. The Town shall provide information to assist the Contractor/Owner in determining, and obtaining permits required. A copy of all permits must be available for inspection on the job site at all times.

All required fees must be paid in advance, prior to issuance of permit and commencement of any construction.

B. **PROJECT OBSERVATION AND REVIEW**

1. All construction and installations shall be subject to observation and review by the Engineer or his authorized Project Representative. Certain types of work may have continuous observation and review.

2. It shall be the responsibility of the person performing the work authorized by the permit to notify the Town that such work is ready for observation and review. The Town requires that every request for observation and review is to be received twenty four (24) hours before such service is desired. Such requests shall be made by telephone to the Town's Engineering Department at 970-674-2400, Monday through Friday between 8:00 A.M. and 4:30 P.M.

   The Contractor/Owner wishing to work outside of these hours and requiring observation and review of such work shall be assessed an observation and review fee based upon the actual costs to the Town associated with supplying a project representative for overtime hours. Additionally, there will be a two (2) hour minimum for observation and review work outside of the normal work hours. The Contractor/Owner is responsible for notifying the Engineering Department of their intent to work overtime hours, weekends, or holidays. Such notice shall be given as soon as possible, but, in no case less than two (2) full working days prior to the overtime work. The Engineer or his representative shall have total control when determining the need for observation and review of any work.

3. The Engineer may make or require other observations and reviews of any work as deemed necessary to ascertain compliance with the Town's Development Standards, Design and Construction Standards, or other standard specifications and codes.

4. The Project Representative is authorized to check all work performed in connection with waterline and/or sewer line construction, including but not limited to clearing and grubbing, excavation/trenching, placement of mains and appurtenances, concrete work, backfill and compaction, connections and/or taps, leakage testing, bacteriological testing, air testing, and materials to be used.

5. When connections to existing mains occur, for all occurrences, connections shall be made following a forty eight (48 hr) hour notice to the Town Engineer and at a time authorized by the Town. The Town shall be given a minimum of five (5) working days notice for shutdowns that involve the notification of residents for service outage.

6. The Project Representative is present on the site to advise contractors on these standards. He has authority to reject defective materials and workmanship, until any questions of issue can be resolved by the Engineer, and advise the Contractor/Owner in complying with construction plans and standards.

7. The Project Representative shall, in no case, act as foreman or perform other duties for the Contractor/Owner, nor interfere with the management of the work done by the Contractor/Owner. The presence or absence of the Project Representative shall not relieve in any degree, the responsibility or the obligation of the Contractor/Owner to perform the work in accordance with the plans or specifications.

8. Prior to commencing work, the Contractor/Owner shall designate, in writing, an authorized representative who shall have complete authority to represent the Contractor/Owner and shall be on the construction site at all times during work activities.

9. The Engineer and Project Representative shall, at all times, have reasonable and safe access to the work whenever it is in preparation or progress and the Contractor/Owner will provide proper facilities for such access for observation and review. The Project Representative has the authority to select locations for tests.

10. The Engineer and/or Project Representative may suspend or stop the work, wholly or in part, until defective workmanship has been corrected for any of the following reasons; 1) for such period of time deemed necessary due to unsuitable weather conditions; 2) for Contractor's/Owner's failure to perform according to applicable standards; 3) for failure to meet all other applicable agreement or permit requirements; or 4) for Contractor's/Owner's failure to provide safe working conditions.

11. Whenever any portion of these specifications are violated, the Town Engineer, by written notice, may order that portion of construction which is in violation of these specifications or other approved plans, specifications, and materials to cease until such violation is corrected. A copy of the notice shall be filed with the Contractor's license application for future review. If deficiencies are not corrected, performance shall be required of the Contractor's Surety. A re-inspection of constructed facilities shall occur at the end of the warranty period.

C. **QUALITY ASSURANCE**

1. Access. The Town shall make periodic checks to verify the quality and progress of the work. The authorized agents and their representatives of the Town shall be provided safe access to the work, whenever it is in preparation or progress. The Contractor/Owner shall provide for such access and for inspection, including maintenance of temporary and permanent access.

2. Rejects. Materials and equipment rejected by the Town shall be identified and marked for removal and shall be removed from the job site.

3. Testing. The Contractor/Owner shall provide materials testing services for verification of materials incorporated into the project including but not limited to concrete, granular and geotextile materials, moisture and compaction requirements are being met in accordance with the frequencies and methods specified in this manual. All quality control test results shall be made available to the

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Engineer immediately after testing. Copies of all tests shall be provided to the Town on a periodic basis and all test results will be submitted in a timely manner and as specified herein.

The Town will review all acceptance testing. Acceptance testing may include but not be limited to tests associated with placing of concrete, bedding preparation, soil compaction, leakage tests, bacteriological tests, video inspections, etc. The Contractor/Owner shall coordinate with the Project Representative as to when he or she is ready for acceptance tests.

4. Re-Testing. The Contractor/Owner shall be responsible for the costs associated with re-testing due to failed quality control and acceptance tests.

5. Conflicts. In case of a conflict or disagreement between codes, standards, laws, ordinances, rules, and regulations or within any document itself, the more stringent requirements, as determined by the Engineer, shall govern. Where work required by drawings or specifications is above the standard required by local regulations or recommended standards, it shall be completed as shown and/or specified.

6. Soil Compaction Tests.

   a. All utility trench backfill within the street right-of-way (including service lines) must be mechanically compacted to not less than ninety five (95%) percent of maximum dry density within plus or minus two (± 2%) percent of optimum moisture content as determined by ASTM D698 or AASHTO T99. Alternatively, utility trenches can also be backfilled with flowable fill to within one (1') foot of finished grade. This includes gas, electric, TV cable, telephone and other utility lines serving the development. All water and sewer services, including water and sewer main stub-outs, shall be installed prior to street construction. Trench backfill in utility easements within twenty (20') feet of right-of-way shall be mechanically compacted to not less than ninety five (95%) percent maximum dry density or backfilled with flowable fill to within one (1') foot of finish grade. Trench backfill in utility easements beyond twenty (20') feet from right-of-way shall be compacted to not less than ninety (90%) percent maximum dry density. Water settlement and/or jetting of trenches shall not be permitted.

   b. Laboratory compaction testing for Quality Assurance shall comply with ASTM D698 or AASHTO T99 – Standard Method of Test for Moisture Density Relations of Soils using a five and a half (5.5 #) pound hammer and a twelve (12") inch drop.

      i. Use method A, B, C, or D, as appropriate, based on soil condition and judgment of the testing laboratory.
      ii. Sample tests shall be representative of materials to be placed.
      iii. Determine and provide optimum density curve for each type of material encountered or utilized.
      iv. Include Atterberg Limits, grain size determination, and, when requested, specific gravity.

   c. Field compaction testing for Quality Assurance shall comply with ASTM D6938 – Standard Test Method for In-place Density and Water Content of soil and soil-aggregate by Nuclear Methods (shallow depth).

   d. Quality Assurance shall comply with ASTM D1557 or AASHTO T180 – Standard Test Method for Lab compaction characteristics of soil using Modified effort.

   e. Test results shall be a basis for Field Quality Control.

7. Submittals.

   a. Submit test certificates with the following information to enable the Engineer to determine compliance with the Specifications for imported materials from each proposed source or supplier.

i. ASTM D698 or AASHTO T99.
ii. ASTM D422 or AASHTO T88.
iii. ASTM D4318 or AASHTO T89 and T90.
iv. Include Atterberg Limits, gradations, and, when requested, specific gravity.

b. All testing shall have been completed within six (6) months prior to incorporating the material into the Project.

D. **PRODUCT DELIVERY, STORAGE, AND HANDLING**

1. Select transportation schedule and truck routes with approval of the Town to keep impacts on the public to a minimum.

2. Do not stockpile excavated materials against existing structures or work.

3. If any material is stockpiled on the job site, it shall be done in an orderly manner and kept a sufficient distance from banks, open trenches, or excavations to avoid overloading and prevent slides or cave-ins.

4. Maintain adequate drainage and erosion control efforts during construction.

5. Do not drop materials or equipment. Use slings, pipe tongs, skids or other controlled methods for handling materials and equipment.

6. Care must be taken to prevent damage to materials and equipment by impact, bending, compression, abrasion or other deleterious handling.

7. Damaged materials and equipment shall not be installed.

8. Lubricant shall not be stored or handled in a manner that will cause contamination.

9. Rubber gaskets shall be stored in a location that protects them from deterioration.

10. Store materials and equipment in accordance with the manufacturer's specifications.

11. Pipe, fittings and joints shall be kept free from dirt, oil and grease.

12. Take special precautions to keep internal parts of materials and equipment clean for use in the potable water system.

E. **MATERIALS, MANUFACTURER'S CERTIFICATES AND RECOMMENDATIONS**

1. All materials and equipment shall be new and of a quality acceptable to the Town's Engineer.

2. If required by the Town's Engineer, the Contractor/Owner shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the instructions of the applicable supplier except as otherwise provided in the Contract Documents; but no provision of any such instructions will be effective to assign to the Town, or any of Town's representatives, any duty or authority to supervise or direct the furnishing or performance of the work.

3. When deemed necessary by the Engineer, the Contractor/Owner shall submit a certificate to the Engineer, secured from manufacturer of all the material used as a permanent part of the project, certifying that their product as used on the project, conforms to all Town specifications. No material shall be used until the certificates are approved by the Engineer.

4. All manufacturer's recommendations, instructions, or specifications regarding installation and use of products shall be considered a part of these Standards and Specifications and of equal force. Any conflict between the manufacturer's instructions and these Standards and Specifications shall be decided and settled by the Engineer and shall not be open for arbitration. All such manufacturer's instructions and submittals shall be presented to the Engineer for approval prior to scheduling a pre-construction meeting.

F. **TRAFFIC CONTROL**

A Traffic Control Plan (TCP) shall be submitted and reviewed by the Town Engineer prior to commencing any work. If the proposed work is in the State Highway right-of-way, then a construction traffic control plan approved by CDOT must be submitted to the Town Engineer prior to commencing any work. The Contractor/Owner shall be responsible for all types of traffic, including pedestrians, in the construction area. SPECIAL ATTENTION SHALL BE GIVEN TO INDIVIDUALS UNDER THE AMERICANS WITH DISABILITY ACT. Any person who makes pavement cuts, excavations, places an embankment, or does any work in public right-of-way, including but not limited to areas along a public street, alley, or sidewalk, shall place barricades, lights, warning signals, detour signs as appropriate, and/or other safety devices at the location, sufficient to warn the public of the hazard, the cut, excavation, or embankment. Safety devices must be in compliance with the Manual on Uniform Traffic Control Devices (MUTCD) and the "Colorado Supplement" to the MUTCD.

The Contractor/Owner shall appoint a Traffic Control Supervisor who shall be responsible for traffic control and who shall be certified by the American Traffic Safety Services Association (ATSSA) and/or the Colorado Contractor’s Association (CCA). The Supervisor must be available twenty four (24) hours per day to resolve traffic control problems during construction. All Traffic Control Supervisors shall have in their possession a current T.C.S. card. A current copy of the T.C.S. card must be on file at the Traffic Operations Division one (1) week in advance of job setup. Provide a Traffic Control Supervisor on job site at all times during job set-up.

All work areas including but not limited to open cuts, trenches, ditches, manholes, and/or other hazards shall be completely surrounded by approved fencing and other appropriate controls to protect and warn pedestrians and persons using bicycles, wheel-chairs, and other vehicles. Temporary walk ways must be provided, with all weather surfacing.

The Contractor/Owner shall maintain fencing to completely surround open cuts for trenches, hydrants, meter pits, manholes, or other hazardous sites.

Intersections and driveways shall be closed only for a minimum amount of time. The Contractor/Owner shall coordinate driveway closures with property owners, one (1) week prior to construction by written notification with final approval by the Engineer.

Removal of any and all signs shall be coordinated with the Engineering Division. It will be the responsibility of the Contractor/Owner to replace/repair said signs until job project is final with Town’s acceptance of the project after the warranty period.

Developments with private streets shall also adhere to these same guidelines; except their traffic control devices shall be permanently maintained by their Homeowner’s Association Group.

The Contractor and Traffic Control Supervisor shall be responsible to change or adjust traffic control devices if conditions warrant.

All flaggers shall be properly trained according to State and Federal guidelines. The Contractor/Owner shall submit copies of flagger's certifications card to the Engineer prior to construction.

The Contractor/Owner shall repair and replace damaged or missing traffic control devices immediately.

The Contractor/Owner shall maintain all necessary barricades, signs, permanent signs, temporary signs, pavement markings, and other traffic control devices between phases of construction even if construction activity ceases for a year or more.

After all waterline and/or sewer line installation and testing, and the streets are constructed, the new streets must be controlled with either construction traffic control barricades or approved temporary or permanent traffic control signage (stop signs, street signs, etc.) and pavement markings. Building permits cannot be issued until appropriate traffic control is in place because of construction traffic into, out of, and throughout the development site. Also, other traffic which is not construction related frequently drives through these sites. Street signs are included as required signage during the building construction phase to insure that emergency services and building inspection staff can find building addresses.

Prior to issuing building permits for any buildings within a phase of development construction, approved permanent traffic control signage and pavement marking must be in place and approved by Town Engineering Division personnel.

All traffic control signage (temporary or permanent) must be in accordance with MUTCD, CDOT Standards, and Town of Windsor standards.

The Town of Windsor will not be responsible for the maintenance of traffic signs or pavement marking as part of a new subdivision until substantial completion. At that time Public Works will complete an inspection of the development to assure all the signs and pavement markings were installed in accordance to approved plans.

If there are deficiencies the Contractor/Owner or other party shall be responsible at no cost to the Town, to bring Traffic Control signs and pavement markings back in compliance with approved plans.

If the traffic control is deemed insufficient, notice will be given to rectify. If after one (1) hour, the deficiencies have not been corrected, the Town reserves the right to temporarily suspend operations until compliance.

The Contractor/Owner shall hold harmless the Town of Windsor and Town staff against claims resulting from accidents involving construction work or construction traffic control.

The Owner/Contractor shall schedule and expedite the work to cause the least inconvenience to the public. Construction or repair work will not be permitted at or near the vicinity of signalized intersections or on any Arterial and Collector streets that have major traffic volumes between the hours of 7:00 a.m. to 8:30 a.m. and 3:30 p.m. to 6:30 p.m. during the rush hours and school term (except in the case of an emergency or with approval from the Engineer). When the work is stopped for the day, all traffic lanes of an Arterial or Collector Street shall be opened to traffic unless extended closure is authorized by the Engineer. A traffic lane shall be considered satisfactory for opening to traffic only if it is paved, patched, or plated in conformance with the Town's Street Specifications. No full street closures will be allowed except in special conditions. No work will be permitted on holidays except in case of an emergency. Construction may not begin until all traffic control devices are in place.

The Contractor/Owner shall remove all traffic control devices immediately upon completion of work or when they are no longer needed (take off job site or move to designated holding area).

G. **CONSTRUCTION STAKES**

1. Stakes, which are the responsibility of the Contractor/Owner unless other arrangements are made with the Engineer prior to initial construction, shall be provided as required for waterline and/or sewer line installation, hydrants, valves, bends, fittings, connections, services/taps, encasements, crossings, PRV's, blow-offs, meter pits, manholes, sewer services, and other structures and furnish all necessary information relating to lines and grades. The Contractor/Owner shall be responsible for the reasonable preservation of all such stakes. Stakes shall not be removed until at least three (3) working days after placement of improvements, unless approved by the Engineer.

2. Construction staking shall be performed under the direct supervision of a Professional Land Surveyor licensed in the State of Colorado.

3. Adequate stakes shall be provided to establish acceptable horizontal and vertical control.

4. All vertical control shall be based on the Town's monumentation and current datum. Proposed reference monumentation shall be approved by the Engineer prior to survey.

5. All horizontal control shall be based on the State Plane Coordinate system.

6. A forty eight (48 hr) hour notice shall be given to the Town by the Contractor/Owner prior to providing construction staking.

7. All survey data and notes, which are developed by the Contractor/Owner or Design Engineer in performing surveys required by the Work, shall be available to the Town for examination and reproduction throughout the construction and warranty periods.

8. The Town Engineer, the Project Representative, and the Design Engineer shall be informed of all field changes to the approved construction drawings. Approval for the changes shall be required from both the Design Engineer and the Town prior to the changes being made in the field.

H. **PRESERVATION OF SURVEY MONUMENTS**

It shall be the policy of the Town of Windsor to preserve and perpetuate survey monuments existing within the Public Right-of-Way and at all other locations.

1. Definitions:

   a. "Aliquot Corner" means any section corner or quarter section corner and any other corner in the Public Land Survey System created by subdividing land according to the rules of procedure set forth in CRS, Section 38-50-101, "Laws of the State of Colorado regulating the Practice of Land Surveying".

   b. "Acceptable monumentation of aliquot corners" means a monument meeting the physical standards for similar monuments set by the United States Bureau of Land Management (Chapter 1V, Manual of Instructions for the Survey of Public Lands, 1973) pursuant to Colorado State Law. Where any aliquot corner falls within the traffic area of a street, road, or highway, the top of the monument shall be placed one-half foot below the surface of the roadway, and if such surface is any form of pavement, the monument shall be provided with a monument box marked "SURVEY", the top of which shall be set one-quarter (¼") inch below any pavement surface.

   c. “Bench Mark” means a permanent or semi-permanent physical mark of known elevation. Benchmarks should include a complete description of the monument with reference ties and the vertical datum with respect to which its elevation is established.

   d. "Professional Land Surveyor" means any individual who practices professional land surveying and is currently registered with the State Board of Licensure for Architects, Professional Engineers and Professional Land Surveyors to practice in the State of Colorado.

2. Preservation. All existing aliquot corner monuments and benchmarks in the Public Right-of-Way shall be preserved whenever possible. Monuments that must be disturbed during construction shall be properly referenced by a Professional Land Surveyor before being disturbed and be replaced with acceptable monumentation at the completion of construction.

3. Reference. All construction plans or drawings shall show the location of aliquot corner monuments and benchmarks known to be in existence in the area of construction. Should an undiscovered or previously unknown monument be found during construction, it shall be preserved or referenced in compliance with the “Laws of the State of Colorado regulating the Practice of Land Surveying Title

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38, Articles 1-101 and Title 38, Articles 53-103" and be replaced with acceptable monumentation at the completion of construction.

4. Replacement. Should an aliquot corner monument or benchmark be destroyed by construction or utility repair the Town shall have authority to cause such monument to be legally replaced and monumented at the Contractor/Owner's expense.

I. JOB CONDITIONS AND CONFORMITY OF WORK AND MATERIALS

1. Underground Obstructions.

   a. Known underground obstructions are as shown on the drawings; however, locations shown may prove inaccurate and other obstructions not known may be encountered. Contractor shall field locate and verify all obstructions whether or not shown on the drawings.

   b. Notify each utility owner and request utilities to be field located by surface reference at least forty eight (48 hrs) hours prior to excavation.

   c. Expose and verify size, location, and elevation of underground utilities and other obstructions where conflicts might exist, sufficiently in advance to permit changes in the event of conflict. Notify Engineer in case of a conflict.

   d. Maintain, protect, and support by shoring, bracing, or other means, existing utilities and appurtenances.

   e. If Contractor elects to remove underground obstructions, the following shall apply:

      i. Replace all underground obstructions which are still in use with new materials.
      ii. Restore to original conditions or better.

   f. Maintain drainage culverts and/or irrigation channels during construction and clean culverts and channels so they are free of all sediment and debris after construction.

2. Blasting. The use of explosives will not be permitted without a blasting permit issued by the governing fire authority and only upon approval by the Town Engineer.

3. Drainage and Groundwater.

   a. Maintain excavations and trenches free from water during construction.

   b. Remove and dispose of surface water and groundwater entering excavations, trenches, or other parts of the work. In addition to good, positive drainage to eliminate standing water, conduct dewatering operations when necessary.

   c. Divert surface runoff and use pumps, gravel blankets, well points, drainage lines, or other means as necessary to accomplish.

      i. Water shall be removed from the trench to the extent necessary in order to provide a firm subgrade and dry conditions for waterline and/or sewer line installation.
      ii. Dewater the excavation or trench until the structure, pipe, or other appurtenance to be installed therein, is completed to the extent that no damage from hydrostatic pressure, floatation, or other cause will result.
      iii. The waterline and/or sewer line being constructed shall not be used at anytime for dewatering.
      iv. The piping used to dewater the trench shall not be left in the trench when backfilled unless approved otherwise by the Town Engineer.

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d. Where applicable, based on Soil Reports, excavations shall be maintained in a dry condition to minimize swell potential.

e. Groundwater barriers shall be installed in high groundwater conditions or if deemed necessary by the Town Engineer.

f. Prior to beginning dewatering operations, the Contractor/Owner shall obtain all necessary permits and appropriate authorization to start dewatering. If groundwater will be discharged or drained into an irrigation ditch, pond, stream or waterway, a CDPHE Dewatering Permit will be required.

   i. Permit applications may take up to thirty (30) days to be reviewed by CDPHE; no dewatering operations may begin until permit approval.
   ii. The Contractor/Owner is required to complete and process the Discharge Monitoring Report (DMR) that is typically a part of the Dewatering Permit.
   iii. Upon completion of the work, the Contractor shall be responsible for completing a CDPHE Discharge Termination Notice.

g. Copies of all CDPHE permits shall be submitted to the Town Engineer prior to the start of dewatering operations. Copies of the permits shall also be kept onsite for the duration of the work.

4. Sequencing.

a. Backfill shall be completed, at the end of each day, to the extent that no damage from hydrostatic pressure, floatation, or other cause will result.

b. Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the time duration of that opening shall be minimized. The Town shall direct the amount of open trench that is acceptable for the condition encountered.

c. During construction, maintain access to private residences and businesses.

d. Contractor shall coordinate the sequence of activities, taking into account work by others, possible easement requirements, permit requirements, and Town requirements.

e. Contractor shall coordinate the beginning of work, excavation near ditches, railroads, road cuts, etc. with the Town, affected parties, and utilities, prior to commencing construction.

f. Contractor shall coordinate pipe filling, chlorination testing, pressure testing, and air and television testing with the Town.

5. Notifications.

a. Contractor shall provide all notifications to residents and affected parties of a shutdown of their potable water system or sanitary sewer system by the use of door hangers at least forty eight (48 hrs) hours (exclusive of holidays and weekends) prior to work.

b. Contractor shall contact One Call Locate at 1-800-922-1987 (811), and verify vertical and horizontal locations of all existing utilities prior to any excavations.

c. Contractor shall give the Town a minimum of forty eight (48 hrs) hours notice (exclusive of holidays and weekends) prior to commencement of work.

d. Contractor shall coordinate all inspections and waterline and sewer line testing with the Town Engineer and/or Construction Inspector and/or Water Department personnel.

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a. Do not backfill structures or trenches or construct fills, embankments, encasements or concrete vaults during freezing weather.

b. Do not place mains, appurtenances, backfill, fills, or embankments, on frozen surfaces.

c. Do not install mains and appurtenances or deposit, tamp, roll, or otherwise mechanically compact backfill, embankments, stabilization courses or pavement courses on submerged or frozen subgrade.

7. Conformity.

All work performed and all materials furnished shall be within the lines, grades, cross sections, dimensions, and material requirements, including applicable tolerances, shown on the plans or indicated in these criteria and specifications.

8. Worksite Maintenance. All Contractor/Owners, Permittees, etc., shall maintain the work site so that:

a. Trash and construction materials are contained and not blown off the work site.

b. Trash is removed from a work site often enough so that it does not become a health, fire, or safety hazard.

c. Trash dumpsters and storage or construction trailers are not placed in the street without specific prior approval of the Town.

d. As the Work progresses, all public rights-of-way and other property shall be cleaned of all rubbish, excess dirt, rock, and other debris, at the sole expense of the Permittee.

e. Utilize best efforts to eliminate the tracking of mud or debris upon any street or sidewalk. Streets and sidewalks shall be cleaned of mud and debris at the end of each day.

f. Utilize erosion control measures to prevent erosion and degradation of water quality.

g. Utilize dust control measures to prevent the blowing and spreading of dust borne material from the work site. Dust control measures may include applying water to soils or aggregates, pre-wetting an excavation area, and dust palliatives.

h. Provide employee and construction vehicle parking so that there is no parking in the neighborhood adjacent to the work site. There shall be no unauthorized parking on sidewalks.

i. Provide necessary sanitary facilities for workers, the location of which shall be approved by the Town Engineer and set forth in the permit.

9. Clean-up.

It shall be the responsibility of each individual Contractor/Owner to keep the work area clean during the prosecution of the work. On a daily basis the Contractor/Owner shall clean up all refuse, mud and dirt on streets, rubbish, scrap materials and debris so that at all times, the site of the work and surrounding area shall present a neat and orderly appearance. Refuse containers shall not be overfilled so that material can be contained.

J. FIELD QUALITY CONTROL

1. Field Compaction Control. Field compaction tests shall be conducted to determine compliance of compaction methods with specified density in accordance with:

a. ASTM D6938 (AASHTO T238) – Tests for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods; or,

b. ASTM D1556 (AASHTO T191) – Tests for Density of Soil In-Place by the Sand Cone Method; or,

c. ASTM D2167 (AASHTO T205) – Tests for Density of Soil In-Place by Rubber-Balloon Method.

2. Gradation. The dry-sieve analysis method of determining the relative proportions of aggregate shall be in accordance with ASTM C136 (AASHTO T27) and as otherwise specified herein. The sieve analysis method for determining the relative proportions of soil shall be in accordance with ASTM D422 (AASHTO T88) and as otherwise specified herein.

3. Moisture Content. Compact soils and other materials within plus or minus two (±2%) percent of optimum moisture content.

4. Geotechnical Engineer.

a. Contractor/Owner shall retain the services of a Geotechnical Engineer and Testing Laboratory, which shall be approved by the Town Engineer, to perform all required materials testing and sampling.

b. Contractor/Owner shall permit the Geotechnical Engineer and Testing Laboratory access to the job site at all times and shall furnish any labor or equipment required to assist the Geotechnical Engineer and Testing Laboratory in obtaining and handling samples at the source of material and at the Project.

c. Contractor/Owner shall provide and maintain, for the sole use of the Geotechnical Engineer, adequate facilities for safe storage of equipment and test specimens on the Project site.

d. Contractor shall not prepare bedding, subgrade, sub-base, stabilization materials or base materials or place any additional paving courses until such testing, inspection and approval thereof has taken place (or waived by the Town Engineer) and resulting recommendations of Engineer have been carried out.

e. The Geotechnical Engineer and Testing Laboratory personnel are not authorized to stop work, to revoke, alter, relax, enlarge, or release any requirements of the Standards, nor to approve, accept, or reject any portion of the Work on behalf of the Town of Windsor.

K. LOAD RESTRICTIONS

The Contractor/Owner shall comply with CDOT Section 105 of the latest edition of the Standard Specifications for Road and Bridge Construction for Truck-Load Weights.

L. UTILITY COORDINATION

1. During construction the Contractor/Owner shall keep inlets, junction boxes, manholes, control valves, and fire hydrants clear at all times. For all waterline and sewer line construction which impacts utilities, the Contractor/Owner shall provide a Town-approved means of temporary service during the approved construction time and properly reconnect such utility service immediately following construction.

2. In the event that a manhole frame, valve box, or other fixture is covered up during construction, it shall be made accessible and cleaned of debris within twenty four (24) hours and raised to the proper alignment and grade unless otherwise approved by the Engineer.

3. Locating or moving existing utilities or coordinating the installation of new utilities is the responsibility of the Contractor(s)/Owner performing the work. Relocation of utilities which are in a public right-of-way or easements shall be the responsibility of the permittee.

4. The Contractor/Owner shall, at all times, take proper precautions for the protection of utilities, the presence of which are known or can be determined by field location of the utility companies. The Contractor/Owner shall be responsible for all expenses relating to damage to utilities. Hand-excavation shall be used whenever necessary. It is the Contractor/Owner's responsibility to call for utility locates and abide by those requirements as outlined by State Statutes. Call UNCC at 1-800-922-1987 (811) for locates.

M. **SAFETY AND PROTECTION**

The Contractor/Owner shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work. Contractor/Owner shall take all reasonable and necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. Employees and other persons onsite who may be affected.

2. The work and materials or equipment to be incorporated therein, whether in storage on or off site.

3. Other property at the site or adjacent thereto, including, but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures, existing waterlines, existing sewer lines, and utilities not designated for removal, relocation or replacement in the course of construction.

Contractor/Owner shall comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

N. **ARCHAEOLOGICAL**

If the Contractor's excavating operations encounter remains of historical or archaeological significance, the operations shall be temporarily discontinued. The Contractor/Owner shall notify the Engineer, who will contact the proper authorities, to determine the disposition of the remains and artifacts. The Contractor/Owner shall protect the site in such a manner as to preserve the artifacts encountered.

O. **PRESERVATION OF PROPERTY**

Existing improvements, adjacent property, utilities, trees and plants that are not to be removed shall be protected from injury or damage resulting from the Contractor/Owner's operations.

P. **PROTECTION OF PUBLIC AND PRIVATE INSTALLATIONS**

The Contractor/Owner shall at all times take proper precautions for the protection of driveway culverts, street intersection culverts or aprons, irrigation crossings, mail boxes, driveway approaches, valve boxes, manholes, survey monuments, underground or overhead utility lines, temporary or permanent street markings, signage, and all other identifiable installations that may be encountered during construction. The Contractor/Owner shall be responsible for all expenses relating to damage to public and private installations.

Q. **PREVENTION OF WATER & AIR POLLUTION AND DUST CONTROL**

1. The Contractor/Owner shall comply with all applicable Federal, State and Local laws, orders, and regulations concerning the control and abatement of water pollution.

2. The Contractor/Owner shall comply with all applicable Federal, State and Local laws, orders, and regulations concerning the prevention and control of air pollution. Unless otherwise indicated on the

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approved plans, material to be disposed of shall not be ignited or burned, either inside or outside the project boundaries.

3. The Contractor/Owner shall comply with all applicable Federal, State and Local laws, orders, and regulations concerning the prevention and control of dust abatement. A dust abatement plan shall be submitted to the Town Engineer. The Contractor/Owner shall have all necessary equipment and labor readily available to control errant dust due to unexpected winds.

R. **TIMELINESS OF REPAIRS**

Repairs which are not termed a hazard to pedestrians, vehicles, or structures, shall be completed within thirty (30) days after receipt of notice to repair from the Public Works Department or the Town Engineer.

S. **SEQUENCE OF CONSTRUCTION**

All curb, gutter, crosspans, and sidewalk shall be constructed after the sanitary sewer, water, non-potable water, and storm sewer mains and services have been installed in accordance with these standards. Water valve boxes, manholes, and associated appurtenances shall be adjusted to final grade after installation of the pavement. Electrical, telephone, cable TV lines, and all other conduit which are in the public right-of-way shall be installed after sewer, water, non-potable water, and storm sewer mains. Conduit for dry utilities shall be installed prior to curb, gutter, and sidewalk. Tunneling under existing sections of curb, gutter and sidewalk is not allowed. Utility easements shall be brought to final grade prior to installation of utilities. New signage and pavement markings must not be installed until after all road work and utilities have been installed.

T. **COMPLETION AND WARRANTY**

Upon written request of the Contractor/Owner, the Engineer and Project Representative shall, in accompaniment with the Contractor/Owner or his representative, physically examine the work and/or phase of the work. One reproducible set of project as-built record drawings shall be prepared by the Contractor/ Owners' Design Engineer and issued to the Town prior to request for Construction Acceptance. The Project Representative shall issue a "punch list" of deficiencies to be completed prior to Construction Acceptance. If no deficiencies are found, a letter of Construction Acceptance will be issued. The letter of Construction Acceptance shall constitute the initiation of the warranty period. The Contractor/Owner shall warranty the completed work to be free of defects in workmanship or materials for a period of at least **one (1) year**. All work that fails or deteriorates during the warranty period shall be replaced. The Contractor/Owner shall be responsible for all costs of material, equipment, labor, and/or traffic control for warranty work. Warranty work shall be completed in accordance with these specifications within thirty (30) days of written notification by the Town, or agreed upon by the Engineer.

The determination of the necessity during the warranty period for the repair or replacement in whole or in part of the work shall rest entirely with the Town Engineer.

U. **ACCEPTANCE**

Upon written request of the Contractor/Owner, the Engineer and Project Representative shall, in accompaniment with the Contractor/Owner, physically examine the work and/or phase of the work. The Engineer or his designee shall issue written partial acceptance of the work with a "punch list" of deficiencies to be completed within thirty (30) days and prior to final acceptance. After all deficiencies are corrected to the satisfaction of the Town Engineer, the Contractor/Owner shall request a letter of Final Acceptance from the Town Planning Department. If no deficiencies are found, the Town will issue a Certificate of Final Acceptance. The issuance of a Construction Acceptance letter and/or letter of Final Acceptance shall not relieve the Contractor/Owner from the responsibility or liability of conforming to the approved plans and specifications.

Such written request shall not be made more than sixty (60) days from the end of the warranty period nor less than thirty (30) days.

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V. **PAYMENTS**

When the CDOT Standard Specifications refers to payment or basis of payment, it shall be disregarded unless specifically referred to in other contract documents associated with the work. The Town of Windsor has no responsibility for payments unless the work was contracted by the Town.

W. **CONFLICTS/QUESTIONS**

When conflicts and/or questions arise between the accepted plans, specifications, development standards, referenced standards, or other contract documents, the Town Engineer shall make the final decision concerning such matters.

X. **LIABILITY**

The Town, the Engineer, or Engineer's authorized representatives charged with the enforcement of these Standards and Specifications, acting in good faith and without malice in the discharge of their duties, will not thereby be rendered personally liable for any damage that may accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of their duties.

Y. **NO WAIVER OF LEGAL RIGHTS**

The Town will not be precluded or stopped by any measurement, estimate, or certificate (made either before or after the completion and acceptance of the work) from showing the true amount and character of the work performed and the materials furnished by the Contractor/Owner, or from showing that any such measurement, estimate or certificate is untrue or is incorrectly made.

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SECTION 02210

TRENCHING, BACKFILL AND COMPACTION

PART 1 – GENERAL

1.1 SCOPE

The Work covered by this section concerns the furnishing of all labor, equipment, supplies, and materials necessary to perform excavation and trenching, including but not limited to subsurface drainage, dewatering, preparation of subgrades, pipe bedding, backfilling, compacting, ground water barriers, materials testing, finish grading, and surface restoration for the proper installation of potable waterlines, fire lines, service lines, fire hydrants, valves, and appurtenances and the installation of sanitary sewer lines, manholes, vaults, service lines, and appurtenances.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C.

1.3 CONSTRUCTION STAKING

Construction Staking shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.G., and as modified herein:

A. All survey notes and construction staking notes shall be kept at the construction site for the duration of the project, and shall be made available to the Town upon request.

B. Adequate Construction Staking shall be provided (under the direct supervision of a Professional Land Surveyor) to establish acceptable horizontal and vertical control. In cases where conflicts may exist or additional Construction Staking may assist the Construction Inspector in determining compliance with the approved Construction Drawings, the Contractor/Owner/Land Surveyor shall supply such staking at no cost to the Town.

C. Cut/offset Construction Stakes shall be placed at a location whereby the stakes are not destroyed during trenching/excavating and backfill operations and can be easily read/identified by the Construction Inspector. If Construction Stakes are destroyed in any manner, the stakes shall be replaced at the direction and request of the Inspector. All offset stakes shall include stationing, offset, and cut or fill dimensions (in feet and tenths of a foot) to top of pipe or invert elevation (flowline) whichever is applicable.

D. The only acceptable method for verifying and confirming horizontal and vertical layout during actual installation of potable water systems shall be by cut/offset Construction Stakes The only acceptable method for verifying and confirming horizontal and vertical layout during installation of sanitary sewer collection systems shall be by calibrated/certified laser device.

E. All survey data, which is developed by the Contractor/Owner or the Design Engineer in performing surveys required by the work, shall be available to the Town for examination and reproduction throughout the design, construction and warranty periods.

F. The Town Engineer, the Construction Inspector, and the Design Engineer shall be informed of all field changes to the approved Construction Drawings. Approval for the changes shall be required from both the Design Engineer and the Town prior to the changes being made in the field.

1.4 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I., and as modified herein:

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A. Existing improvements, adjacent property, utilities, trees, and plants that are not to be removed, shall be protected from injury or damage resulting from the Contractor's operations.

B. Sequencing.

1. Not more than three hundred (300′) linear feet of open trench excavation and waterline or sewer line installation will be allowed at any time. This distance may be amended, by the Town Engineer, based upon job conditions.

2. Initial trench backfill shall be performed within three hundred (300′) linear feet of pipeline installation. This distance may be amended, by the Town Engineer, based upon job conditions.

3. Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the time of duration of that opening is to be minimized.

   a. Contractor shall be solely responsible for construction site safety.

   b. All excavations shall be properly barricaded, signed, and protected to prevent unauthorized access.

4. All trenches shall be backfilled and compacted by the end of each work day. Small areas may be left open if properly fenced and barricaded and the pipe is plugged and covered.

C. Maintenance and Correction.

1. Trench settlement, including any related damage to pavement, curb and gutter, sidewalks, driveways, or other structures, which occurs during the construction and/or warranty periods, shall be the responsibility of the Contractor/Owner.

2. The Contractor/Owner shall be responsible for obtaining all necessary permits to affect repairs within the right-of-way or easement.

3. The Contractor/Owner shall coordinate all repairs with appropriated Town Departments, including the Town Engineer.

D. Verification of Existing Utilities.

1. Responsibility. The Contractor/Owner is responsible for field locating and verifying elevations of all existing sewer mains, storm mains, water mains, service lines, and other utilities at the points of connection shown on the plans, and at utility crossings prior to any reconstruction or repair.

2. Pot Holing. All excavations for utility locates within existing roadways, unless otherwise approved by the Town of Windsor Engineering Division, shall be made by the pot holing method (hydro-excavation). All pot holing locates shall meet the following requirements:

   a. Locate potholes shall not be placed within the wheel track of a travel lane.

   b. All locate potholes in the pavement section shall be cored with a circular coring saw with a maximum diameter of twelve (12") inches. The plug shall be carefully removed without causing damage.

   c. Materials beneath the wearing surface shall be removed by methods approved by the Town Engineer that will not damage the utility or facility.

   d. Excavations for potholes shall be backfilled with flowable fill and capped with non-shrink grout. Native material removed shall not be used to backfill the pothole.

e. The caps on the backfilled potholes shall be five and a half (5½") inches thick in local streets, seven and a half (7½") inches thick in other streets, and shall be finished between one quarter (¼") inch and one half (½") inch below adjacent pavements. Alternate methods must be approved by the Town Engineer.

f. Initial locate potholes may be temporarily repaired, meeting all applicable safety requirements, for no more than thirty (30) days unless additional time is authorized by the Town in writing. Initial locate potholes may be reused during construction.

E. Design Alignment.

1. A dry utility alignment shall not vary greater than eighteen (18") inches plus one half (½) of the diameter of the proposed conduit from the approved design horizontal alignment or twelve (12") inches plus one half (½) of the diameter of the proposed conduit from the approved design vertical alignment without prior Town approval.

2. If the designed alignment of the dry utility conflicts with other facilities not shown on the approved plans, or a design modification is required, the permittee shall submit an alignment modification request and the change shall be approved by the Town prior to proceeding.

3. All underground cables and wires, excluding electrical, shall be placed within a conduit sleeve, with a locator tracer.

4. All underground installations shall have a minimum of thirty (30") inches of cover below the roadway surface.

F. Traffic Control.

1. When it is necessary to obstruct roadways or pedestrian ways that fall under the jurisdiction of the Town, the permittee shall submit traffic control plans, in compliance with the Manual on Uniform Traffic Control Devices (MUTCD), showing all work and including, but not limited to, the following information:

a. Each lane closure scenario, including work zones for locate pothole work.

b. Lane configurations and access locations specific to the actual work zone.

c. Any upstream intersections within five hundred (500') feet of the work zone, showing all impacted inbound lanes to the intersection.

d. Pedestrian route detours showing the nearest crossing intersection at each end of the work zone.

e. Proposed hours of operation of each traffic control setup.

2. All traffic control plans shall be prepared under the supervision of a certified Work Site Traffic Control Supervisor. Documentation of certification shall be submitted with the traffic control plan(s).

3. Unless otherwise noted on the permit, lane closures shall be permitted only between the times shown below:

a. For Arterial and Collector roadways: between 8:30 a.m. and 3:30 p.m. on weekdays, and, upon written approval of the Town Engineer, between 8:00 a.m. to 7:00 p.m. on Saturdays, and 10:00 a.m. to 7:00 p.m. on Sundays.

b. For Local roadways: between 8:00 a.m. and 4:30 p.m. on weekdays, 8:00 a.m. to 7:00 p.m. on Saturdays, and 9:00 a.m. to 6:00 p.m. on Sundays.

4. When conditions warrant, in order to minimize impact to the motoring public, the Town may require that the permittee perform work between the hours of 7:00 p.m. and 6:00 a.m. or on weekends. Timing of reconstruction and repair work may be restricted by the Town Engineer to certain time periods to accommodate traffic and other public uses.

5. When planning construction phasing and developing traffic control plans, the permittee shall make every effort to minimize the impact to the motoring public and maintain the capacity of the roadway system. The Town may require that a traffic control plan be modified to comply with this requirement. The permittee shall make adequate provisions to assure that traffic and adjacent property owners experience a minimum of inconvenience.

6. All signs and devices shall conform to the Manual on Uniform Traffic Control Devices (MUTCD). The devices and signs shall be clean, legible, and properly mounted. All signs and devices shall meet the retro reflective requirements of CDOT Specifications Section 713.10.

7. For major installations, as defined by the Town Engineer, the Town may require that a permittee place Variable Message Boards five (5) working days in advance of the work to notify the traveling public of the upcoming construction impacts. All costs for this work shall be borne by the permittee.

8. If the closure of a street is required for completion of the work, the permittee shall provide all notifications to emergency agencies, government entities, school and bus districts, newspapers, adjacent businesses and homeowner's associations in a format approved by the Town.

9. No permittee shall block access to any private property, fire hydrant, fire station, utility structure, or any other emergency response equipment unless the permittee provides the Town with written approval from the affected agency and/or property owner.

10. When necessary for public safety and when required by the Town, the permittee shall employ flag persons and/or a pilot car to control traffic around or through the work site.

11. The permittee shall be responsible for maintaining all work area signing and barricading required throughout the duration of work. During non-work hours, all signs that are not appropriate shall be removed, covered or turned around so that they do not face traffic.

12. Any deficiencies noted by the Town shall be corrected immediately by the permittee. If the permittee is not available or cannot be found, the Town may make the required corrections and charge the cost thereof to the permittee.

13. If a temporary patch is used and construction traffic control for the project is terminated, the appropriate contractor must obtain another Street Cut Permit, including the approval of a construction Traffic Control Plan, to provide for the final patch work. This is to insure proper approval of traffic control and schedule inspections. If this final patch work is completed within thirty (30) days of the temporary patch, no additional fees will be charged for the follow-up permit.

G. Equipment.

1. The use of trench digging equipment will be permitted only in places where its operation will not cause damage to existing structures or features, otherwise, hand methods shall be employed.

2. Backhoe equipment outriggers shall be fitted with rubber pads or other like protective material whenever outriggers are placed on any paved surface.

3. No tracked vehicles will be permitted on streets unless approved by the Town Engineer. When tracked vehicles are allowed, specific precautions shall be taken to protect the pavement surface and damaged facilities shall be restored to original condition at the Contractor's/Owner's expense.

4. Haul routes for equipment and materials may be restricted as a condition of the Permit.

5. All equipment and trucks tracking mud and debris into a public right-of-way shall be cleaned of mud and debris at the end of each day or as otherwise directed by the Town.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D.

PART 2 – MATERIALS

2.1 GENERAL

A. All bedding and backfill material shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders, corrosive material, debris, broken asphalt and concrete, rocks and stones which are larger than six (6″) inches in any dimension, and any other objectionable material that is not suitable in the opinion of the Town. Rocks or stones which are larger than six (6″) inches in any dimension may be used in trench backfill material with prior written approval of the Town.

B. If job excavated material is not sufficient or suitable for any given layer, suitable material shall be imported per these specifications.

2.2 STABILIZATION MATERIALS

A. If the existing soil in the trench bottom is judged to be unsuitable by the Town or the Design Engineer, at a minimum, the top six (6″) inches of the trench subgrade shall be removed and replaced with stabilization material.

B. If deemed necessary by the Town, more than six (6″) inches of material from the trench bottom may require removal and replacement with a stabilization material.

C. Stabilization material shall be crusher-run rock, conforming to CDOT #357 (ASTM D448, or AASHTO M43), or an approved substitute. When tested with laboratory sieves, the material shall meet the following gradation requirements:

Table 02210-1
Stabilization Material – CDOT #357

Sieve Designation	Percent (%) Passing
2½″	100%
2″	95-100%
1″	35-70%
½″	10-30%
#4	0-5%

D. If tests reveal that material being imported is not of suitable quality for the purpose for which it is intended, Contractor/Owner shall provide alternative material.

2.3 GEOTEXTILE (FILTER) FABRIC

A. In all situations where stabilization material is required, geotextile fabric shall be placed in between stabilization material, and pipe bedding material, unless approved otherwise by the Town.

B. Geotextile fabric shall meet the requirements of CDOT, Table 712-3, Class A fabric, as shown in the following table:

Table 02210-2
Drainage Geotextiles – CDOT, Class A

Property	Specification	Test Method
Grab Strength, N	180 lbs.	ASTM D4632
Seam Strength, N	160 lbs.	ASTM D4632
Puncture Strength, N	80 lbs.	ASTM D4833
Trapezoid Tear, N	50 lbs.	ASTM D4533
Apparent Opening Size	< 0.297 mm	ASTM D4651
Permeability, cm/s^4	k fabric > k soil	ASTM D4491
Ultraviolet Degradation at 500 hours	50% strength retained	ASTM D4355

C. Acceptable geotextile fabric manufacturers are:

1. TenCate – Mirafi 500X

2. Webtec, Inc. Geosynthectics – TerraTex GS

3. Or approved equivalent.

2.4 BEDDING ZONE MATERIALS

A. The bedding zone area shall extend from six (6″) inches (or one quarter (¼) pipe O.D., whichever is greater) below the bottom of the pipe to a minimum of six (6″) inches above the top of the pipe, from edge of trench to edge of trench; herein referred to as the "pipe zone" or "bedding zone".

B. Bedding zone material shall be a clean, free draining, well-graded sand or squeegee sand and shall conform to the following limits when tested by means of laboratory sieves:

1. Well graded sand shall meet the following gradation requirements (percent passing by weight):

Table 02210-3
Well-graded Sand Material

Sieve Designation	Percent (%) Passing
3/8″	100%
No. 4	70-100%
No. 8	36-93%
No. 16	20-80%
No. 30	8-65%
No. 50	2-30%
No. 100	1-10%
No. 200	0-3%

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2. Squeegee sand shall meet the following gradation requirements (percent passing by weight):

Table 02210-4
Squeegee Sand Material

Sieve Designation	Percent (%) Passing
3/8″	100%
No. 200	0-5%

C. Bedding shall not compromise the integrity of poly-wrap or other material/covering used to protect the pipe system from corrosion or other conditions.

D. Water and sewer services shall be bedded with the same material as the main pipeline.

2.5 GROUNDWATER BARRIERS

A. If compacted soil is used for groundwater barriers, it shall meet the following soil classification:

1. CH – inorganic clays of high plasticity, fat clays.

2. SC – clayey sands, sand-clay mixtures.

3. CL – inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clay, clean clays.

B. Concrete shall not be used unless specifically approved by the Town. If concrete is used for groundwater barriers, it shall develop a minimum compressive strength of two thousand (2,000 psi) pounds per square inch after twenty eight (28) days.

2.6 INSULATION MATERIALS

A. Insulation board shall be installed above the bedding zone when the depth of cover over the waterline is less than five (5′) feet; shall be a minimum of two (2″) inches thick; and shall meet the requirements of these Construction Specifications, **Section 1.04.C.5.c., Waterline Layout Requirements**. The design engineer shall address loading requirements where insulation may be required. Acceptable insulation board manufacturers are:

1. Dow Chemical Company – Styrofoam™ Highload extruded polystyrene insulation

2. Owens–Corning.

3. Or approved equivalent.

B. The Town may require that exposed waterlines be insulated from freezing, such as at bridge crossings or where other special freezing related considerations warrant. The limits and amounts of insulation shall be determined by the Town. Impermeable Cellular Glass Insulation shall be “Foamglass” manufactured by Pittsburgh Corning, or approved equal.

2.7 TRENCH BACKFILL MATERIALS

A. Trench backfill material shall be placed from the top of the bedding zone to the ground surface or to the bottom of the pavement subgrade, whichever is applicable.

B. Trench backfill material shall be either soil excavated from the trench, or imported suitable soil as described below:

1. Generally, imported soil used for trench backfill shall be of similar composition, classification, and permeability as the in situ soils.

2. If tests or observations reveal that material being placed is not of suitable quality and structural value, or in the event that sufficient material is not available for trench backfill, from which unsuitable material is removed, the Contractor shall import other material as specified below and as approved by the Engineer.

3. If imported soil is used for trench backfill, it shall comply with **CDOT Standard Specifications** for Class 1 structure backfill and meet the following gradation requirements:

Table 02210-5
Class 1 Structure Backfill

Sieve Designation	% By Weight Passing Sieves
2 inch	100%
No. 4	30 – 100%
No. 50	10 – 60%
No. 200	5 – 20%

In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6) as determined by ASTM D4318 or AASHTO T89 and T90.

4. Flowable backfill meeting the following requirements shall be used to backfill all open cuts in portions of public right-of-way beneath existing paving, curb, gutter, or sidewalk improvements. Alternate backfill methods for large excavations will be considered on an individual review basis with the Town Engineer.

Flowable backfill shall consist of a controlled low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixture. It shall have a design compressive strength between fifty and one hundred fifty (50 and 150) psi at 28 days when tested in accordance with ASTM D4832. The mix shall result in a product having a slump in the range of seven to ten (7" - 10") inches at the time of placement. The Contractor shall submit a mix design for approval by the Town prior to placement. The mix design shall be supported by laboratory test data verifying compliance with the 28-day compressive strength requirements.

Compaction of flowable backfill will not be required. Flowable backfill shall not be allowed to freeze.

Flowable fly ash backfill shall be a thoroughly mixed combination of the following ingredients:

Table 02210-6
Fly Ash Backfill

Ingredients	Lbs./C.Y.
Class C Fly Ash	200 – 400
Class F Fly Ash	1600 – 1800
Water (96 gallons)	800 (or as needed for proper consistency)

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Compaction of flowable fly ash backfill will not be required.

Flowable fly ash backfill shall be delivered and placed from volumetric mobile mixers.

The maximum lift thickness for flowable backfill shall be five (5') feet. Additional lifts shall not be placed until the flowable backfill has lost sufficient moisture to be walked on without indenting more than two (2") inches. Damage resulting from placing flowable backfill in lifts or layers that are too thick or from not allowing sufficient time between placements of lifts shall be repaired at the Contractor's expense.

PART 3 – EXECUTION

3.1 PLANNING AND PREPARATION

A. Pipeline Installations in Existing Streets. All Contractors/Owners, public utility agencies, and private property owners performing waterline or sewer line reconstruction and repair improvements, installing new waterlines or sewer lines, or storing materials or equipment, within any existing Town road right-of-way, must meet the requirements of the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595, Utility Cuts, Backfill, and Pavement Patching**.

B. Pipeline Installations – New Construction.

1. Prior to installation of waterlines and/or sewer lines in undeveloped streets, roadway construction shall have progressed to at least the subgrade stage. Subgrade elevation is defined as the bed of ground or lowest level of a roadway section upon which the subbase is placed to enable the pavement structure to be constructed.

2. The ground surface shall be smooth, clear of debris and free from deep holes, ruts, and large rocks which might hamper waterline installation.

3. Waterlines and/or sewer lines shall be installed where the ground surface is near its final elevation, whether it is located in a dedicated street or not.

4. Topsoil shall be stripped from areas, which are to be disturbed by construction, and stockpiled at a suitable location.

5. Topsoil shall be segregated from non-organic trench excavation material, and debris. Sod shall be either ground up into the topsoil or segregated and disposed of. No sod pieces greater than three (3″) inches shall remain in the topsoil.

6. Topsoil and other soil with organics or other unsuitable material shall not be placed as trench backfill.

7. The Contractor/Owner shall establish the construction limits in accordance with the plans and Town requirements. The natural ground surface shall be cleared of all vegetation; such as, trees, logs, upturned stumps, roots of downed trees, brush, grass, weeds, and all other objectionable materials within the limits of construction.

8. Trees which are to be removed shall be removed in such a manner as not to injure standing trees, plants, and improvements which are to remain. Any object that is designated to remain and is damaged shall be repaired or replaced as directed by the Engineer at the Contractor's expense.

9. All disturbed soil, on or off-site and related to work at the project site, is required to be protected from wind and storm water erosion. To mitigate erosion, the contractor shall use standard erosion control techniques described in " A Guide for Erosion and Sediment Control in Urbanizing Areas of Colorado," published by the Natural Resources Conservation Service, U.S. Department of Agriculture.

3.2 TRENCHING

A. Excavate trenches by open cut methods, except where a boring, jacking, or tunneling is indicated on the Construction Drawings, required by jurisdictional agencies, desired by the Contractor, or as otherwise approved by the Town.

B. Do not use mechanical equipment in locations where its operation would cause damage to trees, culverts, buildings, utilities, structures, or other property above or below ground. In all such locations, hand-excavating methods shall be used.

C. Underground utilities and structures that may interfere with construction shall be exposed and the location verified sufficiently in advance to permit necessary relocations without delays. Temporary support, adequate protection, and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his expense.

D. All existing asphalt or concrete surfacing shall be cut vertically in a straight line, as specified in the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595.3.3, Utility Cuts, Backfill, and Pavement Patching** and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill. All excavated materials which are considered unsuitable for backfill and any surplus of excavated material shall be disposed of properly by the Contractor.

E. Trench Width. Trenches shall be excavated to the width necessary to permit the pipe to be laid and jointed properly and the bedding and backfill to be placed as specified:

1. Use mechanical equipment designed and operated in such a manner that the rough excavated trench bottom elevation can be controlled with uniform trench width and vertical sidewalls from an elevation one (1′) foot above the top of the proposed pipeline to the bottom of the trench.

2. The trench shall be so excavated so that a minimum clearance of six (6″) inches shall be maintained on each side of the pipe for proper placement and densification of the bedding and pipe zone or backfill material.

3. The maximum trench width, measured at the top of the pipe, shall be the outside diameter at the bells plus sixteen (16″) inches regardless of the type of pipe, type of soil, depth of excavation or the method of densifying the bedding and backfill.

4. If the trench width exceeds the maximum allowable trench width, a stronger class pipe shall be required.

F. Trench Alignment. The trench alignment shall be sufficiently accurate to permit pipe to be aligned properly between the pipe and sidewalls of the trench. Do not undercut the trench sidewall to obtain clearance. All excavations shall be made to the lines and grades as established by the approved Construction Drawings.

G. Trench Support. The trench shall be adequately supported and the safety of workers provided for as required by the most recent standards adopted by the Occupational Safety and Health Act (OSHA).

1. Sheeting and shoring shall be utilized where required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the waterline and/or sewer line pipe, or appurtenances being installed, to existing utilities, to existing structures, or to any other existing facility or item.

2. Trench support is the sole responsibility of the Contractor. The Town's presence in no way implies approval of trench support methods being utilized. The Town/Inspector reserves the right not to enter a trench which, in the Inspector's opinion, may be unsafe.

3. Excavated material shall not be placed closer than two (2′) feet from the top edge of the trench. Heavy equipment should not be used, or placed, near the sides of the trench unless the trench is adequately braced.

4. The Town reserves the right to inspect construction sites for compliance to OSHA regulations and general safety considerations. The Town is not responsible for the safety of any party or parties constructing the waterline project.

H. Dewatering. All pipe trench excavations shall be kept free from all water during pipe laying and other related work.

1. Grading shall be performed as required to prevent surface water from entering the excavation.

2. When excessively wet, soft, spongy, or similarly unsuitable materials is encountered at the surface upon which the bedding material is to be placed, dewatering shall be performed and unsuitable materials shall be removed to a depth as determined in the field by the Owner's Geotechnical Engineer and the Town. The degree of soil instability will determine the limits of over-excavation.

3. All over-excavations shall be back-filled and compacted with acceptable bedding material or stabilization material at the Town's discretion.

4. All pipes shall be plugged with a temporary watertight plug at the end of the day.

5. The method of dewatering shall provide for a completely dry foundation at the final lines and grades of the excavation and shall conform to NPDES permitting requirements.

6. Dewatering shall be accomplished by the use of well points, sump pumps, rock or gravel drains placed below subgrade foundations or subsurface pipe drains. All water shall be disposed of in a suitable manner without creating a menace to public health or causing a public inconvenience. No water shall be drained into other work being completed or under construction.

7. The dewatering operation shall continue until such time as it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough backfill to prevent pipe floatation. When pipe is laid in a casing or tunnel longer than thirty (30) pipe diameters, the pipe inside said casing or tunnel shall be secured so flotation does not occur when the pipe is empty.

8. Water shall not be allowed to rise until concrete used in pipeline construction has set a minimum of twenty four (24 hrs) hours and the forms have been removed.

I. Excavation in Rock.

1. If the trench bottom is rock, the Contractor shall over-excavate a minimum of six (6″) inches below the bottom of the trench.

2. The trench width through the extents of the rock excavation shall match the trench width above the top of rock excavation.

3. Backfill with compacted bedding material.

J. Stockpiling Excavated Materials.

1. Pile suitable material for backfilling in an orderly manner a sufficient distance from trench banks to avoid overloading and to prevent slides or cave-ins.

2. Excess excavated materials not suitable or not required for backfilling shall be disposed of properly away from the immediate work area. The Contractor shall legally dispose of all material that is deemed unusable by the Engineer, off of the project site within thirty (30) days.

3. Do not stockpile excavated material against existing structures or appurtenances.

4. Excavated materials shall not be stockpiled beyond the limits of, or in a manner not consistent with, an approved erosion control plan.

5. Contractors shall follow the most current OSHA regulations concerning excavations.

K. Preparation of Trench Bottom.

1. The trench shall be excavated to the proper depth, a minimum of six (6″) inches below the bottom of the pipe, and the trench bottom shall be graded uniformly to provide clearance for each section of pipe.

2. All areas shall be excavated in such a manner as will afford adequate and proper drainage.

3. Loose material, water, and foreign objects shall be removed from the trench.

4. Contractor shall provide a firm sub-grade, which is suitable for placement of bedding material.

5. If, in the opinion of the Town, the Inspector, or the Contractor, and/or the Owner's Geotechnical Engineer, the trench bottom is judged to be unstable, the unstable material shall be removed and replaced with an acceptable stabilization material. Over-excavate to a depth suitable for construction of a stable subgrade, at least a minimum of six (6″) inches.

6. Backfill over-excavation with stabilization material and compact. A geotextile fabric layer shall be placed between the stabilization material and the bedding material. Follow manufacturer's recommendations for installation.

3.3 PIPE ZONE BEDDING

A. Bedding Installation.

1. After completion of the trench excavation and proper preparation of the foundation, a minimum of six (6″) inches of bedding material shall be placed on the trench bottom to provide uniform and continuous support beneath the pipe, including services, at all points between bell ends, or pipe joints.

2. After compaction of the bedding material, the Contractor shall accurately shape the bedding to fit the bottom of the pipe. The intent is to relieve the bell of the pipe of all loading and provide continuous bearing of the pipe barrel on the bedding. Use of a drag template shaped to conform to the outer surface of the pipe will be required if other methods do not give satisfactory results.

3. Bell holes shall be dug deep enough to provide a minimum of two (2″) inches of clearance between the bell and bedding material. All pipes shall be installed in such a manner as to insure full support of the pipe barrel over its entire length.

4. The pipe shall be centered in the trench, adjusted to line and grade and after the joint is made, the pipe zone material shall be carefully placed and tamped under the haunches of the pipe and in the previously dug bell holes.

5. Bedding material shall be simultaneously placed on both sides of the pipe so as not to disturb alignment and grade, in lifts not exceeding eight (8″) inches (loose thickness). Bedding material shall not be dropped on unsupported pipe or pipe which is supported only at the ends. Pipe shall be uniformly supported continuing with bedding lifts.

6. The bedding material shall be sliced under the haunches of the pipe to fill all voids. The slicing shall be performed when the bedding material covers approximately one third (1/3) of the pipe's diameter. The purpose is to ensure uniform support for the pipe.

7. The bedding material shall be compacted with a hand-operated, vibratory device to a minimum density of ninety (90%) percent of the optimum density determined by AASHTO T180. Each lift should be solidly tamped with the proper tools so as not to injure, damage, or disturb the pipe. Water settling for compaction is prohibited.

8. Bedding material shall not be placed in a manner that could damage any protective coating, poly wrap, or similar elements of the pipe system.

   a. Care shall be taken when installing the pipe to prevent damage to protective coatings, poly wrap, or similar elements of the pipe system. Workers shall not walk on coated or protected pipe.

   b. Any pipe coatings, poly wrap, or other surface damage shall be repaired according to manufacturer/supplier recommendations and in a manner acceptable to the Town prior to backfilling.

9. The minimum limits of bedding and pipe zone material shall be from six (6″) inches below the bottom of the pipe to six (6″) inches above the top of the pipe. After compaction and testing, approved backfill may then be installed in the trench.

B. Types of Bedding.

1. Class A Bedding. Class A bedding shall be used for the bedding of ductile iron (DIP) and PVC pipelines at normal depths of cover (*i.e.* four and one half (4½′) feet to ten (10′) feet of cover). Class A bedding shall consist of placing bedding zone material a minimum of six (6″) inches below the bottom of the pipe to six (6″) inches above the top of pipe.

2. Class B Bedding. Class B bedding shall be reviewed for use by the Town for the bedding of ductile iron (DIP) or PVC pipelines when depths of cover are less than four and one half (4½′) feet or it exceeds ten (10′) feet. Class B bedding shall consist of placing approved bedding zone material a minimum of twelve (12″) inches below the bottom of the pipe to twelve (12″) inches above the top of pipe. Additionally, the Design Engineer shall submit calculations to the Town that analyze trench loading and pipe strength for all trenches where depth exceeds ten (10′) feet or less than four and one half (4½′) feet of cover would be available.

3.4 PIPE INSTALLATION

Pipe installation shall be in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation** and/or **Section 02420, Sewer Line Pipe Installation**.

3.5 GROUNDWATER BARRIERS

A. Groundwater Barriers / Cut-off Walls shall be constructed in such a manner as to impede the passage of water through the entire portions of the trench pipe zone and backfill material and shall be installed when high groundwater conditions exist or as directed by the Town Engineer.

B. Groundwater barriers shall be keyed at least one (1′) foot into the trench wall and bottom, and at a minimum extend one (1′) foot above the pipe zone bedding material.

C. Groundwater barriers shall be approximately four (4′) feet long and spaced not more than four hundred (400′) feet apart on waterlines (as measured along the length of pipe) and ten (10′) feet upstream of manholes on sanitary sewer lines.

3.6 INSULATION BOARD

A. Insulation board shall be installed above the bedding zone wherever the depth of cover over the waterline is less than five (5′) feet, and only as approved by the Town Engineer.

1. Insulation board installation shall consist of two (2) overlapping boards, one (1″) inch minimum thickness per board, with off-set joints.

2. Insulation board shall be placed across the full trench width.

3. See these Specifications, **Section 1.04.C.5.c., Waterline Layout Requirements**, for additional requirements.

3.7 BACKFILLING AND COMPACTION

A. Perform trench backfilling as soon as practicable, but only when authorized by the Engineer. The amount of trench or uncompacted backfill or sum of both shall not be more than five hundred (500′) feet at any time.

B. All snow, ice, and/or water shall be removed from the trench prior to proceeding with backfill operations.

C. In areas where existing pavement is to be cut and replaced, the excavated material shall be removed from the site and the trench backfilled with flowable backfill to pavement subgrade elevation. The maximum lift thickness for flowable backfill shall be five (5′) feet. See **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595, Utility Cuts, Backfill, and Pavement Patching**, for additional requirements.

D. Use backfilling and compaction methods and equipment appropriate for the backfill material. Do not use equipment or methods that will transmit damaging shocks to the pipe.

E. Compaction. With the exception of flowable backfill, all trench backfill, including trenches for water and/or sewer services, shall be mechanically compacted,.

1. No compaction shall be done by use of a drop hammer compactor.

2. Compaction efforts shall be conducted in a manner to prevent damage to the pipe, pipe coatings, poly wrap, or other elements of the pipe system.

3. Compaction shall not be performed by flooding, pooling, jetting, or water settling.

4. Heavy compaction equipment shall not be used closer than three (3′) feet to the top of the pipe.

5. Before each lift is compacted, the material therein shall be brought to within one (1%) percent above or two (2%) below the optimum moisture content for the specified compaction. Backfill material which is more than two (2%) percent above the optimum moisture content shall be removed from the site and disposed of by the Contractor at his expense.

6. If, in the judgment of the Town Engineer, the trench shows signs of being improperly backfilled or if settlement occurs, the trenches shall be reopened to a depth required for proper compaction, refilled and re-compacted, all in accordance with these specifications.

F. Backfill Material. Typically, and with the approval of the Town Engineer, trench excavated material will provide suitable backfill material.

1. Wet, soft, or frozen material, pieces of asphalt or concrete or other undesirable substances shall not be used for backfill.

2. The backfill material shall be free from rubbish, organic or perishable material, bituminous pavement, concrete, rock or stones or other lumpy material larger than three (3″) inches in diameter, clods and spongy or frozen lumps of soil.

3. If the excavated material is not suitable for backfill as determined by the Engineer, suitable material shall be imported and utilized and the rejected material hauled away and properly disposed of.

4. Squeegee sand shall not be considered backfill material and shall not extend more than twelve (12″) inches above the top of the pipe.

5. Rock and bedrock encountered in the excavation shall not be used in backfill.

6. Clay and similar material with a plasticity index as determined by ASTM in excess of twenty (20) shall not be considered suitable for backfilling the trenches located in improved streets, roads, highways and thoroughfares, unless the material has been analyzed and recommended as acceptable by a Geotechnical Engineer.

G. Depositing Backfill. Backfill material shall be deposited in uniform horizontal layers which shall not exceed eight (8″) inches (compacted depth), in all areas, unless otherwise approved by the Town Engineer. Perform necessary compactive effort before starting next lift.

1. Equipment or backfilling methods which damage the pipe, pipe coatings, polywrap, or other elements of the pipe system shall not be utilized.

2. Backfill shall be placed to a minimum depth of thirty (30″) inches above the top of the pipe bedding zone before vibratory roller or compacting hammer is used over the pipe.

3. For areas receiving surface improvements after construction, continue backfilling in lifts to the depth of the roadway subgrade. Materials used above the sub-grade level shall conform to the requirements for sub-base, base course and surfacing materials as specified in the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Sections 02227, 02229, 02575,** and **02585**, **Sub-base**, **Aggregate Base Course**, **Bituminous Paving**, and **Portland Cement Concrete Pavement**, respectively.

4. For areas not receiving surface improvements after construction, continue backfilling in lifts to the depth of stripping over all areas disturbed by construction operations and replace topsoil.

5. Any damage to the pipe as a result of the Contractor's backfill and compaction operation shall be repaired and/or replaced by the Contractor.

H. Sheeting Removal.

1. If sheeting is utilized, do not remove sheeting prior to backfilling.

2. Use effective measures to protect the construction, other structures, utilities, and properties during sheeting removal.

3. Voids left by sheeting removal shall be filled with dry sand.

4. Sheeting which is left in place shall be cut off at an elevation of eighteen (18″) inches below the finish grade of unpaved areas, or twenty four (24″) inches below the subgrade of paved areas.

3.8 FIELD QUALITY CONTROL

A. Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C&J.; except subsections 1.3.C&J. shall be modified to include the following:

B. This section applies to all waterlines and sewer lines and appurtenances that are maintained by the Town and located within the public right-of-way, or within dedicated easements. All tests shall be the responsibility of the Contractor/Owner and shall reflect results in accordance with these specifications.

C. Field moisture/density testing.

1. Field tests shall be conducted to determine compliance of moisture/density requirements in accordance with ASTM D6938-08 (Tests for Density of Soil and Soil-Aggregate In Place by Nuclear Methods). Moisture/density testing may also be performed according to ASTM D1556-07 (Standard Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method). Where inconsistent or conflicting test results are obtained, sand-cone tests or other methods of determining in-place moisture and density may be required.

2. Moisture/density tests are the responsibility of the Contractor, and shall be performed by a private Geotechnical Engineer/Consultant.

3. Test results are for discreet locations only and do not guaranty acceptance for trenches or backfill zones in their entirety.

4. The method of testing and the validity of the results shall be the responsibility of the Geotechnical Consultant.

5. Test results shall be submitted to the Town by the Contractor or the Geotechnical Consultant within twenty four (24 hrs) hours of the test, or by the end of the next working day. Copies of field work sheets are acceptable.

6. Summarized test results shall be submitted to the Town prior to the initial acceptance of the water and/or sewer system. Approved test results shall be available on the job site.

7. Moisture/density tests shall be performed in the bedding zone; at a depth not more than two (2′) feet above the top of the pipe bedding; and in two (2′) foot increments up to the final grade.

8. Moisture/density testing shall be performed at a maximum interval of two hundred (200′) lineal feet, as measured along the length of the pipe, or as determined by the Town. Testing may be requested at an increased frequency and/or at specific locations.

9. A minimum of one (1) test shall be performed for every two (2′) vertical feet of compacted backfill material. Test locations shall be staggered within each lift so that successive lifts are not tested in the same location.

10. Moisture/density tests shall be performed on trench backfill, below the finished sub-grade, a minimum of one (1) time for each service line installed. Certain cases may require additional tests, as required by the Town Engineer/Inspector.

D. Compaction and Moisture Content. Compaction and moisture content shall be to the following minimum standards unless recommended otherwise by the Geotechnical Consultant and approved in writing by the Town Engineer. (Reference ASTM D698 or AASHTO T-99, unless otherwise indicated).

1. Ground Water Barriers – ninety five (95%) percent of maximum standard Proctor dry density (ASTM D698) between optimum moisture content and two (2%) percent over optimum moisture content.

2. Pipe Zone Bedding - ninety (90%) percent of maximum dry density.

3. Trench Backfill - ninety five (95%) percent of maximum standard Proctor dry density within plus or minus two (± 2%) percent of optimum moisture content (as determined by AASHTO T-99).

4. If water is added to the material, the material shall be harrowed, disced, bladed, or otherwise worked to ensure a uniform moisture condition.

5. Flowable Backfill – compaction and testing is not required of flowable backfill.

E. R-value. Where required, field tests shall be conducted to determine compliance of the load-bearing capacity of materials as specified in the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595, Utility Cuts, Backfill, and Pavement Patching** in accordance with ASTM D2844 (AASHTO T-90) and as otherwise specified therein.

F. Record Keeping. The Contractor shall keep copies of all quality control test results in a notebook at the job site for the duration of the project.

G. Test Failures.

1. If the required/specified compaction and moisture is not obtained, it shall be the responsibility of the Contractor to re-compact or re-work the material to the required state of compaction and moisture.

2. All failed test areas shall be re-compacted and retested at Contractor's expense.

3. In cases where there is a failure to achieve the required compaction or moisture, the Town may require that the backfill be removed and re-compacted or replaced entirely with suitable materials.

3.9 CLEAN UP

A. Prior to initial acceptance of the water and/or sewer system, the Contractor shall clean street rights-of-way and easements of all rubbish, excess materials, temporary structures and equipment and shall leave the same areas to plus or minus one tenth of (± 0.1′) a foot from the elevations that existed prior to construction of the final grades as shown on the Construction Drawings.

B. Cuts in un-surfaced areas shall be, as a minimum, restored to a condition equal to that prior to construction and in easements, cultivated or agricultural areas, topsoil, to a minimum depth of eight (8″) inches, shall be removed from the area of general disturbance and stockpiled. After installation of all pipelines, appurtenances and structures, and completion of backfill and compaction, the stockpiled topsoil shall be redistributed evenly over disturbed areas. Care should be taken to conform to the original ground contour or final grading plans. Reseeding of cultivated areas shall be such as to return it to as near original condition as possible.

C. Surface cuts in existing roadways shall be, as a minimum, restored to a condition equal to that prior to construction. All streets, gravel or paved, shall be restored in accordance with the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595, Utility Cuts, Backfill, and Pavement Patching**.

D. For a period of one (1 yr) year after completion of the installation (1-year warranty period), the Contractor shall maintain and repair any trench settlement which may occur and shall make suitable repairs to any pipe, fitting, valve, valve box, manhole, vault, pavement, sidewalks, or other structures which may be damaged as a result of backfill settlement as determined by the Town Engineer.

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SECTION 02212

CASING PIPE – BORING AND ENCASEMENTS

PART 1 – GENERAL

1.1 SCOPE

The Work covered by this section concerns the furnishing of all labor, equipment, supplies, and materials and includes the material and construction specifications necessary to perform structural excavation and installation of a casing pipe by boring (or jacking) or as an open trench encasement within the right-of-way or easement, as directed, in conformity with lines, grades, and typical sections as shown on the drawings or as staked in the field. Unless otherwise specified, boring, encasements, structure excavation, and backfill shall include all pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the Work.

The specifications provided herein are minimum guidelines for casing pipe borings and encasements for waterline and sewer line installations. Each casing pipe installation shall be specifically designed by the Design Engineer. The Design Engineer may be required by the Town to provide additional design and installation considerations depending on the situation.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. Design Criteria. The Design Engineer shall specifically design each casing pipe boring (or jacking) installation or encasement.

1. Casing pipe thicknesses specified in this section are based upon superimposed loads and not upon the loads which may be placed on the casing pipe as a result of jacking operations.

2. Provide increased casing pipe strength as necessary to withstand jacking loads.

3. The Design Engineer shall size the casing pipe such that the inside clearance is at least one (1″) inch greater than the maximum outside diameter of the casing spacer runners.

B. Regulatory Criteria.

1. The type of casing pipe material and its properties will normally be specified by the agency granting permission to cross. Such crossings shall be subject to approval by the Town to avoid conflicts in requirements or standards between the Town and the agency granting permission to cross.

2. The Contractor/Owner shall provide a letter, permit, or an approved crossing application to the Town from the agency granting the crossing approval. Copies of all documents required to be sent to the regulatory agency shall be provided to the Town.

3. Contractor/Owner shall obtain the necessary permits from the appropriate agencies, prior to commencing construction.

4. Contractor/Owner shall obtain the necessary bonds, insurance, or indemnity required by the crossing permits for protection against any damage and interference with traffic or service that may be caused by the construction activities.

5. All excavations shall conform to these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I., and as modified herein:

A. Verification of Existing Utilities.

Responsibility. The Contractor/Owner is responsible for field locating and verifying elevations of all existing sewer mains, storm mains, water mains, service lines, and other utilities at the points of connection shown on the plans, and at utility crossings prior to any boring or jacking.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D.

PART 2 – MATERIALS

2.1 CARRIER PIPE

A. The carrier pipe shall be the same nominal diameter as the system main on either side of the casing pipe.

B. In situations where one (1) pipe joint falls within the casing pipe, the carrier pipe material shall be consistent with the pipe material being used for the rest of the pipeline project.

C. For situations where more than one (1) pipe joint falls within the casing pipe, the carrier pipe shall be restrained at the joints through the casing in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

2.2 CASING PIPE

A. Casing pipe material shall be as shown in **Table 02212-1**, **Casing Pipe Specifications**. Acceptable materials shall be as follows:

1. AWWA C900 Polyvinyl Chloride (PVC) Pipe.

2. AWWA C905 Polyvinyl Chloride (PVC) Pipe.

3. AWWA C151 Ductile-Iron Pipe (DIP).

4. Steel Pipe.

a. Steel casing pipe shall be new, smooth steel, conforming to ASTM A139, Grade B (No hydro).

b. The minimum yield point of smooth steel casing pipe shall be thirty five thousand (35,000 psi) pounds per square inch.

c. Clean, used steel pipe which is in good condition, and conforms to the requirements of this specification may be used with the prior approval of the Design Engineer and Town Engineer.

d. The ends of smooth steel casing pipe shall be beveled for field welding. All field welds shall be painted with an epoxy polyamide exterior coating, or a coal-tar enamel exterior coating, which conforms to AWWA C203, Section 2. The minimum thickness of the exterior coating shall be sixteen (16) mil.

e. Smooth steel casing pipe shall have an epoxy polyamide exterior coating, or when required by the Construction Drawings, a coal-tar enamel exterior coating. If the Contractor/Owner elects to omit the exterior coating, one sixteenth of an (1/16″) inch shall be added to the required thickness of the casing pipe.

5. Or approved equivalent.

B. The following table, **Table 02212-1**, **Casing Pipe Specifications**, indicates what casing pipe material and diameter to be used in relation to the carrier pipe diameter and also provides steel casing pipe minimum wall thicknesses and specifies when to use casing spacers and end seals.

Table 02212-1
Casing Pipe Specifications

Carrier Pipe Diameter (in)	Casing Pipe Diameter (in)	Borings and Encasements	Encasements Only
		Steel Casing Pipe- Minimum Wall Thickness (in)	Casing Pipe Materials
2” or less Water Services	4”	0.250	C900 PVC
3”	6”	0.258	C900 PVC C151 DIP Steel
4”	8”	0.322	C900 PVC C151 DIP Steel
6”	12”	0.375	C900 PVC C151 DIP Steel
8”	16”	0.375	C905 PVC C151 DIP Steel
10”	20”	0.375	Steel
12”	24”	0.375	Steel
15”	30”	0.500	Steel
16”	30”	0.500	Steel

· End seals are required on all casing pipe installations.
· Casing spacers are required on all carrier pipes except for 2″ diameter or less water services.

C. Carrier pipes larger than sixteen (16″) inches in diameter shall require a special design be submitted by the Design Engineer and approved by the Town Engineer.

2.3 ACCESSORIES

A. Casing Spacers:

1. Casing spacers shall be in a “centered-restrained” configuration in the casing pipe.

2. Casing spacers shall be sized such that the height of the risers and runners have no less than one (1″) inch clearance from the inside wall of the casing pipe.

3. Band:

a. Casing spacers shall be constructed of circular stainless steel bands that bolt together to form a shell around the carrier pipe.

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b. Material: T-304 stainless steel.

c. Minimum Thickness: Fourteen (14 ga) gauge.

d. Use an eight (8″) inch band width for carrier pipes twelve (12″) inches in diameter and smaller, unless otherwise recommended by the manufacturer.

e. Use a twelve (12″) inch band width for carrier pipes larger than twelve (12″) inches and smaller than sixteen (16″) inches in diameter, unless otherwise recommended by the manufacturer.

4. Risers (Support Structures):

a. Material: Polyvinyl Chloride (PVC).

b. Maximum Thickness: Ten (10 ga) gauge.

c. Reinforced over six (6″) inches in height.

d. Welded to the band.

5. Runners:

a. Material: Glass Filled Polymer or Ultra High Molecular Weight (UHMW) Polyethylene.

b. Minimum Width: Two (2″) inches.

c. Runners shall be mechanically bolted to the risers.

6. Manufacturers:

a. Cascade Waterworks Mfg.

b. PSI Pipeline Seal & Insulator, Inc.

c. CCI Pipeline Systems.

d. Or approved equivalent.

B. Casing Pipe End Seals:

1. Material: Seamless neoprene rubber.

2. Minimum Thickness: one eighth of an (1/8″) inch.

3. Type: Pull on.

4. Bands and Clamps: T-304 stainless steel.

5. Size: Size shall be specific to the casing-carrier pipe combination.

6. Manufacturers:

a. Cascade Waterworks Mfg. – Model CCES.

b. PSI Pipeline Seal & Insulator, Inc. – Model C.

c. CCI Pipeline Systems – Model ESC.

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d. Or approved equivalent.

C. Grout: Grout shall consist of one (1) part Portland Cement and three (3) parts sand.

D. Cathodic Protection: All casing pipes shall have cathodic protection. Anode bags shall be designed on a case by case basis by the Design Engineer, taking into account the size of the casing pipe, soil conditions, moisture conditions, etc. The Design Engineer shall submit a cathodic protection plan and report for review by the Town Engineer.

PART 3 – EXECUTION

3.1 CASING PIPE INSTALLATION

A. General.

1. All excavations shall meet the requirements set forth in these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

2. Adequate vertical and horizontal offset staking shall be provided at both ends of the bored or jacked crossings.

3. Boring pits shall be kept to the minimum size required and shall be properly shored, braced and bulked. Dewatering of the pit shall be maintained along with a firm, graveled working surface for the boring machine. Adequate access to and from the pit which meets OSHA requirements shall always be available.

4. Casing pipe shall be installed to the grade and alignment shown on the approved Construction Drawings. Grade and alignment shall not deviate by more than three tenths (0.3′) of a foot horizontally and one tenth (0.1′) of a foot vertically from that shown on the Construction Drawings.

5. Casing pipe shall be installed as indicated in the Construction Drawings, whether that is by open trench excavation or by jacking methods.

6. Waste material from boring operations shall be contained within the work site, shall be disposed of properly, and shall not be allowed to discharge onto private property or adjacent lands.

B. Polyvinyl Chloride (PVC) Casing Pipe.

1. AWWA C900 and C905 Polyvinyl Chloride (PVC) casing pipe shall be installed in accordance with these Construction Specifications, **Section 02222, Polyvinyl Chloride (PVC) Pressure Pipe**.

2. Polywrap and Cathodic protection is not required of Polyvinyl Chloride (PVC) casing pipe.

C. Ductile Iron (DIP) Casing Pipe.

1. AWWA C151 Ductile Iron (DIP) casing pipe shall be installed in accordance with these Construction Specifications, **Section 02224, Ductile Iron (DIP) Pipe**.

2. Ductile Iron (DIP) casing pipes for open trench installation shall be polywrapped with cathodic protection.

D. Smooth Steel Casing Pipe.

1. Contractor shall provide adequate materials and equipment to ensure a smooth, continuous, and uniform casing pipe with no exterior voids.

2. Each section of casing pipe shall be welded with a full penetration butt weld around the entire circumference of the joint to form a continuous conduit capable of resisting all applied stresses, including jacking stresses. Welds shall be of a size and quality to develop the full strength of the pipe materials. After welding, the joints of coated and wrapped pipe shall be primed and tarred.

3. After completion of the boring operation, a high potential magnesium anode shall be installed at each end of the casing pipe, using a cadweld method.

E. Grouting (As required).

1. In cases where the bore hole is larger than the casing pipe, high pressure grout shall be placed around the outside of the casing pipe to completely fill all voids between the casing and the bore.

2. Grouting operations shall be performed in a sequence which will preclude any deflections which exceed five (5%) percent of the tunnel diameter.

3. After the grout is in place, each hole shall be plugged in order to prevent the backflow of grout.

3.2 CARRIER PIPE INSTALLATION

A. Upon completion of the casing installation, the carrier (waterline or sewer line) pipe shall be installed in the casing pipe at the design grade and elevations shown on the approved Construction Drawings.

B. Install the carrier pipe in accordance with the pipe material's specification.

C. Restrain the carrier pipe joints within the casing pipe, as required, in accordance with **Section 02220, Waterline Pipe Installation**, or **Section 02420, Sewer Line Pipe Installation**, of these Construction Specifications.

D. Install casing spacers one (1′) foot to two (2′) feet on either side of the bell joint and one (1) every six (6′) feet to eight (8′) feet apart thereafter, for a total of three (3) casing spacers per pipe length unless otherwise specified by the manufacturer or Town Engineer. Casing spacers are required on all carrier pipes except for two (2″) inch diameter or less water services.

E. Install risers and runners per manufacturer's recommendations.

F. The carrier pipe shall be installed by pushing the pipe into the casing on "skids" or "runners".

G. Upon completion of the carrier pipe installation, seal the ends of the casing pipe with rubber manufactured casing pipe end seals or boots that effectually couples the pipes and eliminates intrusion of water or other foreign material. End seals are required on all casing pipe installations.

3.3 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J., and as modified herein:

A. Test stations for cathodic protection installations may be required by the Town Engineer, to be determined on a case by case basis.

END OF SECTION

SECTION 02220

WATERLINE PIPE INSTALLATION

PART 1 – GENERAL

1.1 SCOPE

The work covered by this section concerns the furnishing of all labor, equipment, supplies, and materials necessary for waterline pipe installation, including appurtenances, within the public rights of way or public easements within the Town of Windsor, as directed, in conformity with lines, grades, and typical sections as shown on the approved Construction Drawings and/or as staked in the field.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C; and as modified herein:

A. Waterline pipe installation shall conform to the regulations of the Colorado Department of Public Health, and the Water Quality Control Commission.

B. Waterline pipe material shall be consistent for each size/diameter of pipe used throughout the entire portion of the project. Pipe material shall not be interchanged except where another type of pipe material is specifically indicated on the approved Construction Drawings and approved by the Town.

C. All materials used in the construction/installation of potable waterline pipes shall be new and free of defects.

D. Construction Staking.

1. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, for construction staking requirements.

2. Horizontal alignment shall not deviate from the approved Construction Drawings by more than one tenth (0.10′) foot.

3. Vertical alignment shall not deviate from the approved Construction Drawings by more than one tenth (0.10′) foot, as measured from the top of pipe.

E. All waterlines shall be installed in accordance with these specifications and in accordance with AWWA C600 or C605, latest revisions.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I. and as modified herein:

A. Contamination shall be considered as the presence of any visible foreign material that can come into contact with the potable water supply. Contamination shall include, but not be limited to: dust, debris, dirt, mud, including trench water, tools, clothing, rags, petroleum products, paint, pesticides, stones, animals, and insects, or other material, which shall not be permitted in the pipe. Precautions shall be taken to protect the interiors of pipes, fittings, fire hydrants, and valves against contamination.

B. In order to prevent water, debris, and animals from entering the pipe, the open ends of the pipe shall be closed by a watertight plug installed when pipe laying is not in progress. If water is in the trench, the plug shall remain in place until the trench is pumped completely dry. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods.

C. Pipes shall be furnished with all necessary fittings, flanges, gaskets, lubricants, specials, and other accessories, as noted in these standards and shown on the approved Construction Drawings.

D. Use effective measures to prevent uplifting or floating of the pipeline prior to completion of backfilling operations.

E. Protect pipe and appurtenances against dropping and damage. Damaged pipe and appurtenances that are rejected shall be removed from the site.

F. Do not install waterline pipe when the trench contains water or when the trench bottom is unstable as determined by the Town Engineer. Water that is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade, permit connection to be made in dry conditions, and to prevent the entrance of water into the pipeline.

1. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.

2. The excavation or trench shall be kept free from water until the structure or pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3. The pipe shall not be used to dewater the trench.

G. Do not install waterline pipe when weather conditions are unsuitable. Approval from the Town is required when the temperature is thirty two (32° F) degrees Fahrenheit or less.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All materials shall be delivered to the construction site free of contamination. All materials shall be stored in a manner which will prevent contamination of the surfaces which will be in contact with the potable water supply. Storage shall include protection from the weather at all times. To prevent contamination, materials shall be distributed along the project only to the extent that the materials will be installed on that same day.

B. Pipe and fittings shall be loaded and unloaded by lifting so as to avoid shock or damage. Under no circumstances shall such material be dropped. Use slings, pipe tongs, skids or other controlled methods for handling materials and equipment.

C. Care must be taken to prevent damage to materials and equipment by impact, bending, compression, abrasion or other deleterious handling. Contractor shall have proper implements, tools and facilities for the safe and convenient prosecution of the work.

D. Damaged materials and equipment shall not be installed and shall be repaired to the satisfaction of the Engineer, or removed from the construction site.

E. Before the placing of waterline pipe in the trench, each pipe or fitting shall be thoroughly cleaned of all foreign material, kept clean at all times, and examined for cracks or defects before installation.

F. Joint lubricant shall be as supplied by the pipe manufacturer and shall not be stored or handled in a manner that will cause contamination.

G. Rubber gaskets shall be stored in a location that protects them from deterioration.

H. Store materials and equipment in accordance with the manufacturer's specifications.

I. Pipe, fittings and joints shall be kept free from dirt, oil and grease and other sources of contamination.

J. Take special precautions to keep internal parts of materials and equipment clean for use in the potable water system.

PART 2 – MATERIALS

2.1 TRACER WIRE AND TEST STATION

A. Locator (tracer) wire shall be copper wire, twelve (12 ga) AWG, solid wire, six hundred (600) volt, watertight insulation, Type UF, for direct bury.

B. Connectors shall be solderless, 3M direct bury splice kit, or approved equivalent.

C. Test Station shall be flush-to-grade type complete with insulated terminal block with four (4) terminals.

D. Test Station cover shall be lockable, cast-iron lid, with "WATER TEST" cast in the cover.

E. Test Station section to be four (4″) inch inside diameter with a twelve to eighteen (12″ - 18″) inch long flared plastic shaft to prevent removal.

F. In exceptional situations, where approved by the Town Engineer, a valve box may be used as the Test Station. The tracer wire should be run on the outside of the valve box up to a point twelve (12″) inches below finish grade and enter into the box at that elevation.

2.2 LOCATOR TAPE

Warning locator tape with "WATER LINE BURIED BELOW" printed on the tape shall be installed, where required, about eighteen (18″) inches above the top of the pipe. At a minimum, locator tape shall be colored blue, three (3″) inches wide, four (4) mils thickness, non-detectable polyethylene. The tape shall be solid colored with black letters.

2.3 WATERLINE PIPE

A. Waterline pipe material shall be either Polyvinyl Chloride (PVC) pressure pipe or Ductile Iron (DIP) and shall conform to the requirements as detailed in these Construction Specifications, **Section 02222** and **Section 02224**, respectively.

B. The same type of pipe material shall be used for each size pipe. Pipe material shall not be interchanged, except where another type of pipe material is specifically indicated on the approved Construction Drawings.

2.4 POLYETHYLENE ENCASEMENT

A. All buried ductile iron pipe (DIP) and fittings shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be eight (8) mil minimum thickness.

2.5 WATERLINE APPURTENANCES

The material for waterline appurtenances, such as fire hydrants, bends, fittings, restraint systems, valves, Pressure Reducing Valves, air-vacs, blow-offs, thrust blocks, etc, shall conform to the requirements as detailed in these Construction Specifications, **Section 02230, Waterline Appurtenances**.

2.6 PIPE JOINT LUBRICANT

Joint lubricant shall be as supplied by the pipe manufacturer, and approved by the Town Engineer. Joint lubricant shall be non-toxic, water soluble, and certified to meet NSF Standard 61. The lubricant shall not support the growth of bacteria, shall not have deteriorating effects on the gasket material, and it shall not impart taste or odor to water in the pipe.

2.7 TAPPING SLEEVES AND TAPPING VALVES

A. Tapping sleeves and valves are required for connections to existing distribution waterlines unless otherwise indicated on the approved Construction Drawings.

B. Tapping sleeves for polyvinyl chloride (PVC) pipe and ductile iron pipe (DIP) shall have a stainless steel body. Tapping sleeves for existing waterlines consisting of other materials shall be as directed by the Town Engineer.

C. Accepted manufacturers are:

1. ROMAC.
2. Ford.
3. Smith Blair.
4. JCM Industries, Inc.
5. Or approved equivalent.

D. Tapping sleeves shall be rated at two hundred (200 psi) pounds per square inch, minimum, working pressure.

E. Tapping sleeves shall provide a one hundred (100%) percent leak-tight seal.

F. Prior to the Contractor ordering tapping sleeves, manufacturer's shop drawings and specifications shall be submitted to the Town Engineer for review and acceptance.

2.8 CONCRETE FOR THRUST BLOCKS AND ENCASEMENTS

Concrete to be utilized for thrust blocks and encasements shall be six (6) sack concrete with a minimum compressive strength of three thousand five hundred (3,500 psi) pounds per square inch at twenty eight (28) days.

PART 3 – EXECUTION

3.1 INSPECTION

A. Pipe barrel and fittings shall be inspected and cleaned to ascertain that they are free of dirt or other foreign objects prior to installation. Bell ends and spigot ends are to be examined with particular care.

B. Pipe and fittings shall be inspected for cracks, dents, abrasions, damaged linings or coatings, or other flaws prior to installation. Damaged or flawed pipe or fittings shall be rejected and removed from the construction site.

C. Gaskets. Gaskets shall at all times be protected from damage and contamination. Gaskets which display any imperfection in manufacturing, any damage, or any contamination shall not be used.

D. Operational Inspection. At the completion of the project and in the presence of a Town representative, the Contractor shall operate all valves to ascertain that the entire facility is in good working order, all valve boxes are centered and valves are open, all hydrants operate and drain properly, all curb boxes are plumb centered and water is available at all curb stops.

3.2 PREPARATION

A. In anticipation of waterline pipe installation, excavating for the trench, trench bottom stabilization, and proper pipe bedding shall conform to the requirements as detailed in **Section 02210, Trenching, Backfill and Compaction**.

B. Existing Utilities.

1. The horizontal and vertical location of existing utilities shall be field verified prior to start of waterline construction.

2. Any deviation in construction from what is shown on the approved Construction Drawings shall be reported to the Design Engineer and the Town Engineer immediately and documented on the "As-Constructed", Project Record Drawings.

3.3 PIPE INSTALLATION

A. All pipe, fittings, valves, hydrants, and other appurtenances shall be carefully lowered into the prepared trench by means of a hoist, ropes, or other suitable tools or equipment in such a manner as to prevent damage to the waterline materials and protective coatings and linings. Nylon lift straps may be required at the direction of the Town Engineer. Under no circumstances shall waterline materials be dropped or dumped into the trench.

B. All pipe and fittings shall be carefully examined for cracks or other defects immediately before installation in final position. Bell ends and spigot ends are to be examined with particular care. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench.

C. No pipe or appurtenant structure shall be installed upon a foundation into which frost has penetrated or at any time when the Inspector deems there is a danger of ice formation or frost penetration at the bottom of the excavation. No pipe or related structure shall be installed unless backfilling can be completed before the formation of ice and frost.

D. All pipe shall be installed with the bell ends pointing in the direction that the work is progressing unless directed otherwise by the Town Engineer.

E. Whenever necessary, waterline pipe shall be cut to conform to proper location of fittings, line, or grade. Cuts shall be straight and true, performed in a workman like manner without damaging the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe. Burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed to create a beveled end in accordance with the manufacturer's recommendations. Tools used in cutting pipe should be designed specifically for the material and shall be approved by the Town Engineer. Flame cutting of pipe by means of an oxygen-acetylene torch shall not be allowed.

F. Immediately before joining two (2) lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. Caution shall be exercised to ensure that the correct type of gasket is used. The circular rubber gasket shall be flexed inward and inserted into the gasket recess of the bell socket. A thin film of approved gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe, per the manufacturer's recommendations. The lubricated joint shall be kept clean until joined.

G. The spigot end of the pipe shall be placed in the socket with care to prevent the joint from contacting the ground. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted. Care shall be taken so that the bell end of the pipe will not be deflected. The seating of the gasket shall be checked around the entire circumference of the pipe by visual and feeler gauge inspection. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to

the full depth of the joint. Field-cut pipe lengths shall be filed or ground to resemble the spigot end of such pipe as manufactured. Burrs shall be removed and all dust shall be wiped off of the jointing surface. Previously completed joints shall not be disturbed during the jointing operation. Joints shall be watertight and free from leaks.

H. Complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. Make adjustments in line and grade by scraping away or filling pipe bedding under the entire length of the pipe, except at bells, and not by wedging, blocking, or mounding up the pipe or bells. The waterline shall be installed so that a uniform positive or negative grade is maintained between the designed high and low points. When laying pipe on curves, the pipe shall be kept in alignment by deflection joints, bending of the barrel portion of the pipe, or fittings. See **Section 1.04.C.1.d**, of these Specifications, for detailed specifications. All curved pipe installation shall require the use of mechanically restrained joints (MEGALUG® or approved equal).

I. Unless approved otherwise by the Town Engineer, horizontal and vertical pipe alignment(s) shall not deviate more than one tenth (0.10′) foot from that shown on the approved Construction Drawings.

J. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints. Pipe shall be placed in such a manner that the specific bedding provides a solid uniform bearing surface for the full length of the barrel. Do not disturb the pipe after the jointing has been completed. Take effective measures to prevent opening of joints during bedding and backfilling operations.

K. Whenever the waterline pipe is left unattended, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent children and animals from entering the pipe. All temporary plugs shall be approved by the Town Engineer. The plugging of pipe shall also apply to lunch breaks, as well as overnight.

L. All Ductile Iron pipe (DIP), fittings, valves, and valve boxes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02224, Ductile Iron Pipe**, or AWWA C105-77, for further specification and instructions.

M. Extra care should be used in handling Polyvinyl Chloride (PVC) Pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. See these Construction Specifications, **Section 02222, Polyvinyl Chloride Pipe**, or AWWA C900-75, for further specification and instructions.

N. Tracer Wire. Locator (tracing) wire shall be installed with all waterline pipe regardless of pipe material type.

1. Locator (tracing) wire shall be attached to the top of each barrel section of pipe with approved direct bury tape. Tape wire every ten (10′) feet maximum and each side of every joint, fitting, or valve.

2. Locator (tracing) wire shall be brought to the surface on the outside of a valve box or inside of a test station behind every fire hydrant, or at the end of a temporary dead end run. Test station shall be installed in accordance with these specifications. Use of a valve box for a test station shall only be permitted in extreme situations.

3. Four (4′) feet of wire shall be installed inside of the valve box and coiled inside the valve box at the top.

4. Tracing wire shall not be attached to the valve box.

5. Connect/splice wires together at tees and crosses. Wire shall be connected/spliced using approved direct bury splicing kits.

6. Testing.

a. Locator (tracing) wire shall pass testing prior to Initial Acceptance.

b. Test tracing wire system by passing current through the wire and demonstrate that the tracing wire is capable of locating the pipe.

c. If wire will not pass current testing, locate break in circuit and repair and test until tracer wire works in accordance with its intended use.

7. The Test Station with lockable, cast-iron lid shall be located within twelve (12″) inches from the fire hydrant. Reference Town Standard Drawings.

O. Backfill. The Contractor shall employ effective measures to prevent the separation of joints during jointing, bedding, and backfilling operations. Bedding material shall not be dropped onto unsupported pipe, which has been set to alignment and grade. Complete installation of bedding and backfill in accordance with these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

P. Depth of Bury. The minimum depth of cover shall be five (5′) feet from the finished grade to the top of the pipe, except as otherwise indicated on the Construction Drawings. The maximum depth of cover shall six (6′) feet from the finished grade to the top of the pipe, except as otherwise indicated on the Construction Drawings or as directed by the Town Engineer.

3.4 CONNECTIONS TO EXISTING POTABLE SYSTEM

A. When connecting to the existing Town of Windsor potable water distribution system, ONLY Town Water Department personnel shall operate existing system valves. The Contractor shall provide at least forty eight (48 hrs) hours notification prior to needing any valve operated, except in the case of emergencies and as approved by the Town Engineer.

B. At locations where connections to existing mains are to be made, the Contractor shall locate the existing mains both vertically and horizontally and verify their exact size and material in advance of the time scheduled for making the connections.

1. Prior to connecting to existing mains, the Contractor shall have all labor, materials, and equipment ready to connect the fitting to the existing main, so as to keep the shutoff time to a minimum.

2. The Town of Windsor Water Department personnel will examine the existing pipe or appurtenance and specify any necessary adjustments in line, grade, or connection requirements to accomplish the connection.

3. Use effective measures to prevent contamination to existing potable waterlines.

4. Under **NO** circumstances shall a non-disinfected potable waterline be connected to an existing disinfected potable waterline without an isolation valve and prior approval by the Town.

5. As soon as possible after making the connections, the Contractor shall flush the connection so as to prevent contamination of the existing facilities. The Contractor shall take every precaution necessary to prevent dirt or debris from entering the main.

C. The Town shall not be responsible for valve water tightness on existing facilities. If existing valves leak, the Town of Windsor Water Department may assist in reducing the influx of water, but the contractor must use methods at his own disposal to dewater the trench and complete any required testing and disinfection of the potable waterline.

D. All connections shall have a working isolation valve installed to separate new construction from the existing system. New construction shall not be placed in service with the existing system until the new system has been tested and accepted by the Town.

E. No connection will be installed or allowed by the Town unless the water supply is protected as required against actual or potential backflows. Water service to any premise will be discontinued if a backflow prevention device that is required is not installed, tested, and maintained, or if it is found that a backflow prevention device has been removed, tampered with, by-passed, or if an unprotected cross-connection exists. Service will not be restored until such conditions or defects are corrected.

3.5 THRUST RESTRAINT

A. General. All fittings (*i.e*. bends, reducers, tees, crosses, plugs/caps, valves, etc.) shall be mechanical joint. Each fitting joint shall also be restrained with approved restraint devices (*i.e.* MEGALUG® or approved equal) and thrust blocks.

B. Thrust Blocks.

1. Thrust blocks shall be constructed at all bends and fittings which result in unbalanced line thrust. When a line is wet tapped, a thrust block shall be installed.

2. The design engineer shall determine the required size and dimensions of thrust blocks to use and they shall be shown on the Construction Drawings. The minimum size of thrust blocks shall be determined from the table in the "Thrust Block Detail" in the Town's Standard Detail Drawings.

3. All concrete thrust blocks shall be designed for shape and size assuming a minimum internal pipe pressure of two hundred (200 psi) pounds per square inch plus water hammer surge pressures and the proper soil bearing pressure (one thousand (1,000 psf) pounds per square foot, minimum).

4. The concrete thrust block bearing surface shall be excavated into undisturbed soil. The concrete thrust block shall be extended from the fitting or valve to be blocked, to solid undisturbed earth.

   a. All loose soil shall be disposed of, and the location where the thrust block is to be constructed shall be carefully shaped to provide a uniform bearing surface of the required size.

   b. The concrete thrust block bottom shall be flat and sides shall be vertical. The vertical sides of the concrete thrust blocks shall be formed to allow for symmetrical thrust.

   c. If soil is to be disturbed, making a concrete thrust block unusually large or unusable, alternate restraining systems must be approved by the Town Engineer prior to continuing with waterline installation.

5. The concrete thrust block shall be formed to provide access to fittings, valves, and fire hydrants. Care shall be taken not to block outlets or to cover bolts, nuts, clamps, or other fittings or to make them inaccessible.

6. Concrete thrust blocks shall be constructed so that all joints and drain and weep holes are clear and accessible.

7. The concrete placed for thrust blocks shall be separated from fittings, valves, and fire hydrants (where required) by placement of an eight (8) mil polyethylene film barrier, or bond breaker between the fitting and the thrust block to aid in ease of future removal or repair. For the same reason, if a large thrust block is to be placed, it shall be separated into sections by a suitable material.

8. The Town shall be notified a minimum of twenty four (24 hrs) hours prior to concrete being placed.

9. Backfill may be placed over the thrust block once the surface has set sufficiently to resist the weight of the backfill; however, no tamping or compacting shall be allowed above the thrust block for a minimum of twenty four (24 hr) hours after placement.

10. Concrete for thrust blocks must set a minimum of forty eight (48 hr) hours prior to the performance of a hydrostatic test on the water system.

11. Concrete for thrust blocks shall be protected from freezing.

C. Pipe/Joint and Fitting Restraints**.**

1. If concrete thrust blocks cannot be used for any reason, or if otherwise required, push-on and mechanical pipe joints may be restrained with mechanical restraint systems.

2. The design engineer shall determine the length of required pipe restraint, for the pipe material being used, PVC or DIP, in accordance with AWWA M41 *Ductile-Iron Pipe and Fittings* or AWWA M23 *PVC Pipe – Design and Installation*, latest revision.

   a. Restraint calculations shall be submitted to the Town Engineer for review and approval.

   b. Restrained length(s) shall be indicated on the Construction Drawings.

3. Where required, harnessing of joints may be accomplished by the use of mechanical joint restraint systems or by use of one of the several proprietary joint restraint systems supplied by pipe manufacturers. Regardless of the system used, restrained lengths of pipe for various fittings, where harnessing is utilized or required, shall be at least equal to the lengths shown on the approved Construction Drawings or as directed by the Town Engineer.

4. The proprietary systems will require approval of the Town Engineer prior to use.

5. All mechanical joint restraints shall be incorporated in the design of a mechanical joint gland. The gland shall be manufactured of ductile iron conforming to ASTM A-536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C111, C153, and C605, latest revision.

6. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, shall be used to ensure proper actuation of the restraining devices. When the nut is sheared off, a standard hex nut shall remain.

7. The mechanical joint restraint device for ductile iron pipe (DIP) shall have a working pressure of at least two hundred fifty (250 psi) pounds per square inch with a minimum safety factor of two to one (2:1).

8. The mechanical joint restraint device for polyvinyl chloride pipe (PVC) shall have a working pressure of at least one hundred fifty (150 psi) pounds per square inch with a minimum safety factor of two to one (2:1).

9. The mechanical joint restraint devices shall be of the type listed below, or equal, approved by the Town Engineer prior to construction:

   a. For Ductile Iron Pipe (DIP): EBAA Iron, Inc. MegaLug 1100 series (4”-12”). Uni-Flange UFR-1400-D.

   b. For Polyvinyl Chloride Pipe (PVC): EBAA Iron, Inc. MegaLug 2000 PV series (4”-12”). Uni-Flange UFR-1500-C.

10. Unless approved otherwise by the Town Engineer, waterline pipe sizes twelve (12″) inches and less in diameter shall utilize the following restraint scenarios:

    a. When the distance between any combination of fittings is greater than one full/un-cut standard laying length of PVC or DIP pipe, a minimum of one full/un-cut standard laying length of pipe shall be mechanically restrained at each fitting and the joint between the fittings shall be restrained with a MEGALUG®, or approved equal, restraint harness back from each fitting.

b. When the distance between any combination of fittings is less than one full/un-cut standard laying length of PVC or DIP pipe, the connecting pipe between shall contain no joints and each fitting shall be mechanically restrained as indicated herein.

11. For waterline pipe sizes twelve (12″) inches in diameter and less, the design engineer shall specify the type of fitting joint, pursuant to these Standards, and in certain cases, may also be required to provide thrust/restraint calculations to determine if other and/or alternate thrust/restraint systems are necessary.

12. For all waterline pipe sizes, pipe joints through lowerings, crossings and within a casing pipe shall be restrained with mechanical joint devices.

3.6 FIRE LINES

A. All fire sprinkler lines are subject to approval by the Town Engineer and the Windsor Severance Fire Protection District (W-SFPD).

B. Fire sprinkler lines shall not be installed in trenches with other conduits/utilities.

C. Fire sprinkler lines larger than three (3″) inches in diameter shall be restrained Ductile Iron Pipe (DIP) and require concrete thrust blocking at the main and a gate valve at the main.

D. Fire sprinkler line gate valves shall be placed at the main. These gate valves shall be mechanical joint (MJ) valves and fasten to a mechanical joint (MJ) anchor tee (swivel tee) on the main and shall be installed with a screw type, adjustable valve box with cap stamped “FIRE”.

E. All fire sprinkler lines shall be installed with a fire line Back-Flow-Prevention device (BFPD) with flow detection. The BFPD shall be located on the fire line riser at the piping entrance into the building or structure.

F. All materials and testing shall, at a minimum, conform to these specifications and as directed by the Windsor Severance Fire Protection District (W-SFPD).

3.7 CROSS-CONNECTION CONTROL

All connections to Town of Windsor water distribution facilities and appurtenances shall conform to the latest edition of the Colorado Cross-Connection Control manual and the Colorado Department of Public Health and Environment/Water Quality Control Commission.

3.8 PROTECTION OF METALLIC SURFACES

A. If the supplied material has not been factory coated, or the coating has been damaged prior to or during installation, the material may be protected by concrete encasement or the following method, only upon approval of the Town Engineer:

B. Ferrous metal rods, rebar, clamps, bolts, nuts, and other accessories which are subject to submergence or contact with earth or fill material, and not encased in concrete shall be protected with two (2) coats of coal tar enamel, or rubberized spray-on undercoating, or an approved equal, and wrapped with an eight (8) mil polyethylene film.

1. The first coat of coal tar enamel shall be applied to a dry, clean surface.

2. The first coat of coal tar enamel shall be allowed to dry before the second coat is applied.

3.9 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J; except subsection 1.3.J. shall be modified to include the following:

A. Bacteriological Tests. Reference these Construction Specifications, **Section 02260, Waterline Disinfection**, for specifications and requirements.

B. Pipe Leakage Tests. Reference these Construction Specifications, **Section 02270, Hydrostatic Testing**, for directions and requirements.

C. Tracer Wire Testing.

1. Test tracing wire system by passing electric current through the wire and demonstrate that the tracing wire is capable of locating the PVC pipe.

2. If the wire will not pass current testing, locate the break in the circuit and repair and test until tracer wire works in accordance with its intended use.

D. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

E. PVC Pipe. Reference these Construction Specifications, **Section 02222, Polyvinyl Chloride Pipe**, and/or AWWA C900-75, for further specification and information.

F. DIP Pipe. Reference these Construction Specifications, **Section 02224, Ductile Iron Pipe**, and/or AWWA C104-74, for further specification and information.

END OF SECTION

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SECTION 02222

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for polyvinyl chloride (PVC) pressure pipe for potable water distribution systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of plastic pressure pipe in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All PVC waterline materials shall be furnished complete with all gaskets, fittings, lubricants, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C. and as modified herein:

A. The Town has established minimum design safety factors for its water distribution system piping considering working pressures of one hundred fifty (150 psi) pounds per square inch concurrent with water hammer surge pressure of one hundred twenty (120 psi) pounds per square inch for pipes eight (8″) inches and smaller, one hundred ten (110 psi) pounds per square inch for ten and twelve (10″ and 12″) inch pipes, and seventy (70 psi) pounds per square inch for pipes fourteen (14″) inches and larger.

B. In general, selection of type of pipe shall be left to the discretion of the Professional Engineer in charge of design; however, the Town Engineer reserves the right to deny use of certain type of materials in specific circumstances.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All polyvinyl chloride (PVC) pressure pipe shall be new and supplied by one manufacturer, unless directed otherwise by the Town Engineer.

B. Markings on Pipe.

1. All PVC waterline pipe and DIP fittings shall be marked by the manufacturer with the appropriate AWWA designations.

2. Any PVC pipe and fittings not properly marked will be rejected and removed from the job site.

3. All PVC materials shall be clearly marked on the exterior surface of the pipe with the following:

   a. AWWA and ASTM designations.
   b. Size and Class.
   c. Date of Manufacture.
   d. Name and Trademark of Manufacturer.

e. National Sanitation Foundation (NSF) certification.

C. Handling.

1. PVC pipe shall not be handled in a manner which will cause damage to the pipe.

2. Pipe shall be lifted with wide fabric lifting slings. Do not use hooks.

3. Do not drop pipe or fittings including dropping on cushions.

4. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.

5. Polyvinyl chloride (PVC) pipe flexibility is reduced along with impact resistance as temperatures approach freezing, which increases the need for additional care when handling and installing PVC pipe during cold weather.

D. Storage.

1. Pipe lubricants shall be stored and handled in a manner that will avoid contamination.

2. Rubber gaskets shall be stored in a cool, dark location which protects them from deterioration.

3. Pipe, gaskets, lubricants, and all other installation materials shall be stored in accordance with the manufacturer's specifications.

4. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.

5. Pipe which has a longitudinal deflection greater than one eighth (1/8 in/ft) inch per foot shall not be used.

6. Ultraviolet Deterioration.

a. No pipe stored outside and exposed to sunlight shall exceed the manufacturer's recommended exposure time. This time shall begin from the date of manufacture.

b. If the exposure time will be greater than the manufacturer's recommended time, or stored outside and exposed to sunlight for more than thirty (30) days, the pipe shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering.

c. Polyvinyl chloride (PVC) pipe that exhibits excessive ultraviolet deterioration and cracking, which in the opinion of the Town Engineer degrades the pipe quality, will not be permitted for installation and shall be removed from the job site.

7. Polyvinyl chloride (PVC) pressure pipe must conform to the cast iron pipe (Iron Pipe Size) outside diameters. All pipes must be Underwriters' Laboratory approved.

PART 2 – MATERIALS

2.1 POLYVINYL CHLORIDE (PVC) PIPE – SLIP JOINT

A. General.

1. This specification shall apply to slip joint PVC pipes (six (6″) inch, eight (8″) inch, ten (10″) inch, and twelve (12″) inch nominal diameters) with ductile iron equivalent outside diameters (Iron Pipe Size).

2. All PVC pressure pipe shall be manufactured in accordance with AWWA C900 (DR-18), with elastomeric gaskets conforming to ASTM F477.

B. Pipe joints shall be manufactured utilizing an integral extruded bell with elastomeric gasket push-on type joint with rubber gaskets and machined (beveled) pipe ends to form a push-on type slip joint.

C. All sizes of pipe under these specifications shall be pressure class as shown on the approved Construction Drawings. Plastic pressure pipe shall be a minimum Class 150, with a dimension ratio of eighteen (DR-18).

D. Each length of pipe shall have a nominal laying length of twenty (20′) feet. Except when making closure connections to fittings, random/cut lengths of pipe are not acceptable.

E. Unless otherwise approved by the Town Engineer, all PVC pipe used in the Town's water distribution system shall be "blue" color.

F. With slip (push-on) joints, sizes fourteen (14″) inches through twenty four (24″) inches ONLY, shall be manufactured in accordance with AWWA C905.

1. For fourteen (14″) inch diameter and larger PVC pipes, the Pressure Rating shall be 165, (DR-25) for water system pressures up to one hundred (100 psi) pounds per square inch.

2. Pressure Rating 200 (DR-21) shall be used for these larger PVC pipes where system pressure exceeds one hundred (100 psi) pounds per square inch.

2.2 MECHANICAL JOINT PIPE RESTRAINTS

A. This specification shall cover restrained joint PVC pipe with diameters equivalent to ductile iron pipe (Iron Pipe Size).

B. Acceptable manufacturers and styles for PVC pipe are:

1. Mechanical Joint Restraint:

a. EBBA Iron, Inc. MEGALUG®, SERIES 2000 PV.

b. Uni-Flange Corp SERIES 1500.

2. Slip Joint Restraint:

a. EBBA Iron, Inc. MEGALUG®, SERIES 1500.

b. Uni-Flange Corp SERIES 1390.

2.3 FITTINGS AND COUPLINGS

A. General. This specification shall cover restrained joint PVC pipes with outside diameters equivalent to ductile iron pipe (Iron Pipe Size).

B. All fittings and couplings shall be manufactured in accordance with AWWA C153, C111, and C104.

C. All fittings and couplings shall be MJ, mechanical joint.

D. All fittings and couplings shall be made of ductile iron, Cl. 350, with a minimum working pressure rating of three hundred fifty (350 psi) pounds per square inch.

E. All mechanical fitting bolts shall be tightened by the use of a torque wrench as per the manufacturer's specification.

2.4 POLYETHYLENE ENCASEMENT

A. All buried ductile iron fittings, valves, fire hydrants, and bell restraints shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be eight (8) mil minimum thickness.

2.5 JOINTS

A. All joints on polyvinyl chloride (PVC) pressure pipe shall be slip (push-on), using an integral bell with an elastomeric-gasket conforming to ASTM F477.

B. Pipe gasket lubricant shall be approved for potable water systems per the NSF. The lubricant shall not support the growth of bacteria, shall not have deteriorating effects on the gasket material, and it shall not impart taste or odor to water in the pipe.

2.6 TRACER WIRE AND TEST STATIONS

Locator (tracer) wire and test stations shall meet the specifications given in these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine PVC pipe and Ductile Iron fittings and do not use sections containing: cracks, flaws, broken or loose lining, dents, and any abrasions.

B. Mark defective pipe or fitting and remove from the job site.

3.2 PREPARATION

A. For trenching, bedding, backfilling, and compaction, reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. Cutting the Pipe.

1. Cut pipe smooth, straight, and at right angles to the pipe axis with saws or pipe cutters designed specifically for the PVC pipe material.

2. Remove burrs and wipe off all dust from the jointing surfaces and inside pipe and fittings.

3. Bevel the cut end in accordance with manufacturer's recommendation.

4. Do not disturb previously installed joints during cutting operations.

C. Field Joints.

1. Use slip (push-on) joints for buried PVC pipe except where indicated otherwise on the approved Construction Drawings.

2. Dirt, oil, grit, and other foreign material shall be removed from the inside of the bell and the outside of the spigot.

3. If gaskets are not previously inserted into the bell end of the pipe by the manufacturer, ensure that the correct type of gasket is used and flex the rubber gasket inward and insert into the gasket recess.

4. Apply a thin film of lubricant to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.

5. Keep the lubricated joint surfaces clean until joined.

3.3 INSTALLATION

A. For PVC pipe installation, reference these Construction Specifications, **Section 02220, Waterline Pipe Installation.**

B. PVC pipe shall not be installed when the air temperature or the soil temperature is thirty two (32° F) degrees Fahrenheit or less, unless otherwise approved by the Town Engineer.

C. No waterline pipe may be covered or backfilled until inspection of pipe and bedding has been made and the Town has given approval.

D. Joints.

1. PVC waterline pipe shall be joined to the tolerances recommended by the manufacturer (*i.e*. the home line).

2. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted.

3. Previously completed joints shall not be disturbed during the jointing operation.

4. All joints shall be watertight and free from leaks.

5. Testing of all pipe under concrete and asphalt surfaces shall be performed prior to placing concrete or asphalt.

6. Concrete thrust blocking shall be installed against undisturbed earth in a manner that allows access to joints, fittings, clamps, bolts, etc.

E. Curves in Trench Alignment.

1. PVC pressure pipe may be curved to change alignment or grade or to avoid obstructions, when directly approved by the Town Engineer.

2. When laying PVC pipe on curves, the pipe shall be kept in alignment by deflection joints, bending of the barrel portion of the pipe, or fittings. See these Construction Specifications, **Section 1.04.C.1.d**, for detailed specifications.

3. Curved pipe installation may require the use of mechanically restrained joints (MEGALUG® or approved equal), as required by the Town Engineer.

4. For longitudinally bending of the barrel of PVC waterline pressure pipe, the minimum bending radius shall not be less than three hundred times (300 x O.D.) the pipe outside diameter.

5. Previously installed joints shall be backfilled with at least thirty six (36″) inches of compacted trench backfill and longitudinally bending of the PVC pipe barrel shall be accomplished manually. PVC pipes larger than twelve (12″) inches in diameter may not use this method

F. Tracer Wire.

1. Tape the locator (tracer) wire to top centerline of PVC pipe at least every ten (10′) feet and each side of every joint, fitting, or valve, with approved direct bury tape or plastic tie straps and secure such that the wire remains in place during embedding of the pipe.

2. Locator (tracing) wire shall be brought to the surface on the inside of an approved test station behind every fire hydrant. Provide a four (4′) foot loop of wire at each test station. Tracing wire shall not be attached to the valve box.

3. Connect/splice wires together at tees and crosses. Wire shall be connected/spliced using approved direct bury splicing kits.

3.4 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J., and as modified herein:

A. Bacteriological Tests. Reference these Construction Specifications, **Section 02260, Waterline Disinfection**, for specifications and requirements.

B. Pipe Leakage Tests. Reference these Construction Specifications, **Section 02270, Hydrostatic Testing**, for directions and requirements.

C. Tracer Wire Testing.

1. Test tracing wire system by passing electric current through the wire and demonstrate that the tracing wire is capable of locating the PVC pipe.

2. If the wire will not pass current testing, locate the break in the circuit and repair and test until tracer wire works in accordance with its intended use.

D. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for soil compaction testing requirements and specifications.

END OF SECTION

SECTION 02224

DUCTILE IRON PIPE (DIP)

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for ductile iron pressure pipe and fittings (DIP) for potable water distribution systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of DIP in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All DIP waterline materials shall be furnished complete with all gaskets, lubricants, linings, fittings, flanges, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C. and as modified herein:

A. The Town has established minimum design safety factors for its water distribution system piping considering working pressures of one hundred fifty (150 psi) pounds per square inch concurrent with water hammer surge pressure of one hundred twenty (120 psi) pounds per square inch for pipes eight (8″) inches and smaller, one hundred ten (110 psi) pounds per square inch for ten and twelve (10″ and 12″) inch pipes, and seventy (70 psi) pounds per square inch for pipes fourteen (14″) inches and larger.

B. In general, selection of type of pipe shall be left to the discretion of the Professional Engineer in charge of design; however, the Town Engineer reserves the right to deny use of certain type of materials in specific circumstances.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All ductile iron (DIP) pressure pipe shall be new and supplied by one manufacturer, unless otherwise directed by the Town Engineer.

B. Markings on Pipe.

1. All DIP waterline pipe and fittings shall be marked by the manufacturer with the appropriate AWWA designations.

2. Any DIP pipe and fittings not properly marked will be rejected and removed from the job site.

3. All DIP materials shall be clearly marked on the exterior surface of pipe and fittings with the following:

   a. AWWA and ASTM designations.
   b. Size and Class.
   c. Date of Manufacture.

d. Name and Trademark of Manufacturer.
e. National Sanitation Foundation (NSF) certification.

C. Handling.

1. DIP pipe shall not be handled in a manner which will cause damage to the pipe or linings.

2. Pipe shall be lifted using slings, pipe tongs, or skids. Do not use hooks.

3. Do not drop pipe or fittings including dropping on cushions.

4. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.

5. Do not skid or roll DIP pipe into pipe already on the ground.

D. Storage.

1. Pipe lubricants shall be stored and handled in a manner that will avoid contamination.

2. Rubber gaskets shall be stored in a cool, dark location which protects them from deterioration.

3. Pipe, gaskets, lubricants, and all other installation materials shall be stored in accordance with the manufacturer's specifications.

4. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.

5. Do not exceed maximum stacking heights listed in AWWA C600, Table 1.

PART 2 – MATERIALS

2.1 DUCTILE IRON (DIP) PIPE – SLIP JOINT

A. General. This specification shall apply to all ductile iron pipes and fittings (DIP).

1. All DIP pressure pipe shall be manufactured in accordance with AWWA C151.

2. The diameter indicated on the drawings shall mean the nominal inside diameter of the pipe or fitting.

3. DIP shall be furnished in normal laying lengths of either eighteen (18′) feet or twenty (20′) feet. Except when making closure connections to fittings, random/cut lengths of pipe are not acceptable.

4. Unless otherwise approved by the Town Engineer, gaskets and lubricants used with DIP shall be as recommended and/or specified by the manufacturer.

5. The grade of iron used in the manufacture of DIP shall have a minimum tensile strength of sixty thousand (60,000 psi) pounds per square inch, a minimum yield strength of forty two thousand (42,000 psi) pounds per square inch, and a minimum percent of elongation of ten (10%) percent (grade 60-42-10).

6. All DIP shall have standard thickness cement mortar lining in accordance with AWWA C104.

7. DIP shall have a bituminous coating, minimum one (1) mil thick, on the pipe exterior, unless otherwise specified.

B. Specific.

1. This specification shall apply to slip joint ductile iron pipes and fittings (DIP), six (6″) inch, through forty two (42″) inch nominal diameters.

2. Pipe joints shall be a “push-on single gasket” type slip joint conforming to AWWA C111.

3. With slip (push-on) joints, DIP shall be manufactured in accordance with AWWA C151 and shall conform, at a minimum, to the following pressure classes:

   a. Sixteen (16″) inch diameter and smaller DIP pipes shall be Pressure Class 350.

   b. Larger than sixteen (16″) inch diameter DIP pipes shall be Pressure Class 250.

   c. Higher pressure class DIP may be required if the Town Engineer determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.

2.2 DUCTILE IRON PIPE (DIP) - MECHANICAL JOINT

A. General.

1. **Section 2.1.A.**, above, shall apply.

B. Specific.

1. This specification shall apply to mechanical joint ductile iron pipes and fittings (DIP), six (6″) inch, through twenty four (24″) inch nominal diameters.

2. Pipe joints shall be a “mechanical single gasket” type conforming to applicable requirements of AWWA C111.

3. All mechanical joint glands shall be sized and drilled in accordance with AWWA C111.

4. The minimum grade of iron shall be grade 60-42-10.

5. With mechanical joints, DIP shall be manufactured in accordance with AWWA C151 and shall conform, at a minimum, to the following pressure classes:

   a. Twelve (12″) inch diameter and smaller DIP pipes shall be Pressure Class 350.

   b. Larger than twelve (12″) inch diameter DIP pipes shall be Pressure Class 250.

   c. Higher pressure class DIP may be required if the Town Engineer determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.

6. Corrosion resistant, high strength, low-alloy, steel bolts and nuts shall be used where in contact with the soil, immersed, or in splash zones in accordance with ASTM A325, Type 3. Acceptable bolts and nuts are:

   a. Cor-Ten.

   b. Usalloy.

   c. Or approved equivalent.

2.3 DUCTILE IRON PIPE (DIP) - FLANGED JOINT

A. General.

1. **Section 2.1.A.**, above, shall apply.

B. Specific.

1. This specification shall apply to flanged joint ductile iron pipes and fittings (DIP), six (6″) inch, through thirty (30″) inch nominal diameters.

2. Pipe joints shall be a "flanged single gasket" type joint, conforming to applicable requirements of AWWA C111.

3. All pipe flanges shall be sized and drilled in accordance with ASME B16.1, Class 125.

4. The minimum grade of iron shall be grade 60-42-10.

5. With flanged joints, DIP shall be manufactured in accordance with AWWA C115 and shall conform, at a minimum, to Pressure Class 250.

   a. Higher pressure class DIP may be required if the Town Engineer determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.

6. Corrosion resistant, high strength, low-alloy, steel bolts and nuts shall be used where in contact with the soil, immersed, or in splash zones in accordance with ASTM A325, Type 3. Acceptable bolts and nuts are:

   a. Cor-Ten.

   b. Usalloy.

   c. Or approved equivalent.

2.4 DUCTILE IRON PIPE (DIP) - RESTRAINED JOINT

A. General.

1. **Section 2.1.A.**, above, shall apply.

B. Specific.

1. This specification shall apply to restrained joint ductile iron pipes and fittings (DIP), six (6″) inch, through forty two (42″) inch nominal diameters.

2. Pipe joints shall be "restrained, push-on single gasket" type joint conforming to applicable requirements of AWWA C111.

3. The minimum grade of iron shall be grade 60-42-10.

4. With restrained slip (push-on) joints, DIP shall be manufactured in accordance with AWWA C151 and shall conform, at a minimum, to the following pressure classes:

   a. Sixteen (16″) inch diameter and smaller DIP pipes shall be Pressure Class 350.

   b. Larger than sixteen (16″) inch diameter DIP pipes shall be Pressure Class 250.

   c. Higher pressure class DIP may be required if the Town Engineer determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.

5. Acceptable manufacturers for boltless, restrained joint DIP pipe are:

   a. U.S. Pipe – TR FLEX.

b. Pacific States Pipe – TYTON AND FASTITE RESTRAINED JOINT.

c. American D.I.P. – FLEX-RING.

d. Or approved equivalent.

6. Bell type restrained joint DIP pipe shall incorporate a mechanical joint type socket with a mechanical joint (MJ) restraint.

2.5 MECHANICAL JOINT (MJ) RESTRAINTS

A. General.

1. Mechanical Joint (MJ) restraints shall be used for restraining fittings, valves, fire hydrants, and fire lines.

2. All MJ pipe restraints shall be incorporated in a follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Twist-off nuts, sized same as tee-head bolts, shall be used to ensure proper actuating of restraining devices.

B. Glands shall be manufactured of DIP conforming to ASTM A536, grade 60-42-10. Restraining devices shall be of ductile iron heated to a minimum hardness of two hundred seventy (270) GHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C153.

C. MJ restraint devices shall have the following minimum working pressures and shall not be less than piping working pressure ratings:

1. For pipes four (4″) inch through twenty four (24″) inch diameter, minimum working pressure shall be three hundred fifty (350 psi) pounds per square inch with a minimum safety factor of two to one (2:1).

2. For pipes larger than twenty four (24″) inch diameter, minimum working pressure shall be two hundred fifty (250 psi) pounds per square inch with a minimum safety factor of two to one (2:1)

D. Acceptable manufacturers and styles are:

1. Mechanical Joint Restraint:

a. EBBA Iron, Inc. MEGALUG®, SERIES 1100.

b. Uni-Flange Corp SERIES 1400.

2. Slip Joint Restraint:

a. EBBA Iron, Inc. MEGALUG®, SERIES 1700.

b. Uni-Flange Corp SERIES 1450.

2.6 MECHANICAL COUPLINGS

A. All mechanical couplings shall be of a gasketed, sleeve-type, with correct diameter to properly fit the pipe. Tolerance on pipe and coupling, together with proper bolt and gasket arrangements, shall be sufficient to ensure permanent watertight joints under all conditions.

B. Materials used in the manufacture of these couplings shall be new and shall conform to AWWA C219.

C. Couplings shall be sufficiently wide, so that each type of pipe joined will have as much pipe end inserted in the coupling as is provided by the standard push-on mechanical joint for the pipe size and type involved.

D. Styles of couplings include straight couplings, insulating couplings, reducing couplings and transition couplings.

E. Acceptable manufacturers (or approved equivalent) and styles are:

1. Straight couplings:

a. Dresser	Style 138	all sizes.
b. Romac	Style 501	4″ thru 12″.
Romac	Style 400	14″ and larger.
c. Smith-Blair	Style 416	all sizes.

2. Insulating couplings:

a. Romac	Style IC501	4″ thru 12″.
Romac	Style IC400	14″ and larger.
b. Smith-Blair	Style 441	all sizes.

3. Reducing couplings:

a. Dresser	Style 62	all sizes.
b. Romac	Style RC501	4″ thru 12″.
Romac	Style RC400	14″ and larger.
c. Smith-Blair	Style 415	all sizes.

4. Transition couplings:

a. Dresser	Style 162	all sizes.

2.7 FITTINGS

A. All fittings shall be new and manufactured in accordance with AWWA C104, C110, and C111.

B. All fittings shall have either mechanical joint or flanged joint connections.

C. All fittings shall be made of either gray-iron or ductile iron, and have a minimum working pressure rating of three hundred fifty (350 psi) pounds per square inch for pipes four through twenty four (4″ - 24″) inch diameter and two hundred fifty (250 psi) pounds per square inch for pipes larger than twenty four (24″) inch diameter.

D. All sizes of ductile and gray iron fittings shall be furnished with a cement-mortar lining of standard thickness or fusion-bonded epoxy coating in accordance with AWWA C116.

E. Iron used in the manufacture of fittings for these specifications shall be grade 60-42-10.

F. All mechanical fitting bolts shall be tightened by the use of a torque wrench as per the manufacturer's specification.

2.8 POLYETHYLENE ENCASEMENT

A. All buried ductile iron fittings, valves, fire hydrants, and bell restraints shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be eight (8) mil minimum thickness.

2.9 TRACER WIRE AND TEST STATIONS

Locator (tracer) wire and test stations shall meet the specifications given in these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine DIP pipe and fittings and do not use sections containing: cracks, flaws, broken or loose lining, dents, and any abrasions.

B. Mark defective pipe or fitting and remove from the job site.

3.2 PREPARATION

A. For trenching, bedding, backfilling, and compaction, reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. Cutting the Pipe.

1. Cut pipe smooth, straight, and at right angles to the pipe axis with saws or pipe cutters designed specifically for the DIP pipe material.

2. Do not damage the pipe or cement lining.

3. Use new abrasive wheels for ductile iron pipe, do not use oxyacetylene flame.

4. Grind cut ends and rough edges smooth.

5. Bevel the cut end for push-on joints, in accordance with manufacturer's recommendation.

6. Remove burrs and wipe off all dust from the jointing surfaces and inside of pipes and fittings.

7. Do not disturb previously installed joints during cutting operations.

3.3 INSTALLATION

A. For DIP pipe installation, reference these Construction Specifications, **Section 02220, Waterline Pipe Installation.**

B. No waterline pipe may be covered or backfilled until inspection of pipe and bedding has been made and the Town has given approval.

C. Field Joints.

1. Use slip (push-on) joints for buried DIP pipe except where indicated otherwise on the approved Construction Drawings.

2. Use flanged joints at unburied locations unless indicated otherwise on the approved Construction Drawings.

3. All joints shall be watertight and free from leaks.

4. Use MEGALUG®, or approved equivalent retainer gland on all exposed mechanical joints for restraint.

5. Block, anchor, or harness all mechanical couplings, push-on, or mechanical joints.

6. Install concrete thrust blocking against undisturbed earth in a manner to allow access to joints.

D. Polyethylene Encasement.

1. Polyethylene encasement is required at all buried locations including fittings with mechanical joints.

2. Prior to installing polyethylene encasement, clumps of mud or other contaminants shall be brushed off the pipe or fitting surface.

3. Polyethylene encasement material shall be hand wrapped and installed in accordance with AWWA C105, Method A, latest revision.

4. Polyethylene encasement shall be so applied as to prevent the contact of backfill material with the DIP fitting or pipe, but is not intended to be a completely airtight and/or watertight enclosure.

5. Maintain a solid encasement on pipe with the polyethylene. Tape to existing lines and the ends of encasement sections. Use pressure sensitive tape to close seams or hold overlaps.

6. Repair rips, punctures or other damage with adhesive tape or with a short length of polyethylene encasement wrapped around the pipe and secured in place.

7. Prolonged exposure to sunlight will eventually deteriorate polyethylene film. Keep exposure to sunlight to a minimum.

E. Curves in Trench Alignment.

1. DIP pipe may be curved to change alignment or grade or to avoid obstructions, when directly approved by the Town Engineer.

2. When laying DIP pipe on curves, the pipe shall be kept in alignment by deflection joints or fittings. See **Section 1.04.C.1.d**, of these Construction Specifications, for detailed instructions.

3. Curved pipe installation may require the use of mechanically restrained joints (MEGALUG® or approved equal), as required by the Town Engineer.

4. Previously installed joints should be backfilled with at least thirty six (36″) inches of compacted trench backfill.

F. Tracer Wire.

1. Tape the locator (tracer) wire to top centerline of DIP pipe at least every ten (10′) feet and each side of every joint, fitting, or valve, with approved direct bury tape or plastic tie straps and secure such that the wire remains in place during embedding of the pipe.

2. Locator (tracing) wire shall be brought to the surface on the inside of an approved test station behind every fire hydrant. Provide a four (4′) foot loop of wire at each test station. Tracing wire shall not be attached to the valve box.

3. Connect/splice wires together at tees and crosses. Wire shall be connected/spliced using approved direct bury splicing kits.

3.4 JOINT INSTALLATION

A. Joints – General.

1. Dirt, oil, grit, excess coating, and other foreign material shall be removed from the inside of the bell and the outside of the spigot.

2. If gaskets are not previously inserted into the bell end of the pipe by the manufacturer, ensure that the correct type of gasket is used and flex the rubber gasket inward and insert into the gasket recess.

3. Make certain that the pipe is marked with a depth mark before assembly to ensure that the spigot is inserted to the depth mark according to manufacturer's recommendations.

4. Apply a thin film of lubricant to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.

5. Do not permit the joint surfaces to come in contact with the ground. Keep the lubricated joint surfaces clean until joined.

6. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted.

7. Previously completed joints shall not be disturbed during the jointing operation.

8. All joints shall be watertight and free from leaks.

9. Testing of all pipe under concrete and asphalt surfaces shall be performed prior to placing concrete or asphalt.

10. Concrete thrust blocking shall be installed against undisturbed earth in a manner that allows access to joints, fittings, clamps, bolts, etc.

B. Push-on Joints.

1. DIP waterline pipe shall be joined to the tolerances recommended by the manufacturer (*i.e*. the home line.

2. Complete the joint as described in A. above.

3. The seating of the gasket shall be checked around the entire circumference of the pipe by visual inspection. Use of a feeler gauge may be required by the Town Engineer.

C. Mechanical Joints.

1. Complete the joint as described in A. above.

2. Tighten nuts alternately on opposite sides of the pipe or fitting to produce equal pressure on all parts of the gland.

3. Tighten by the use of a torque limiting wrench as per the manufacturer's specification, or per the following ranges:

Table 02224-1
Torque Wrench Ranges

Pipe Diameter (in)	Bolt Diameter (in)	Torque (ft-lb)
4″ to 24″	3/4″	75 - 90
30″ to 42″	1″	100 - 120

4. Holes in mechanical joint bells shall straddle the top (or side for vertical piping) centerline.

D. Flanged Joints.

1. Extend DIP completely through screwed-on flanges.

2. Machine finish the pipe end and flange face in a single operation.

3. Eliminate any restraints on the pipe that would prevent uniform gasket compression or cause unnecessary stress in the flanges.

4. Do not assemble mechanical connections until all flanged joints have been tightened.

5. Alternately tighten bolts spaced on opposite sides of the pipe to assure uniform gasket compression.

6. Holes in flanges shall straddle the top (or side for vertical piping) centerline.

3.5 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J., and as modified herein:

A. Bacteriological Tests. Reference these Construction Specifications, **Section 02260, Waterline Disinfection**, for specifications and requirements.

B. Pipe Leakage Tests. Reference these Construction Specifications, **Section 02270, Hydrostatic Testing**, for directions and requirements.

C. Tracer Wire Testing.

1. Test tracing wire system by passing electric current through the wire and demonstrate that the tracing wire is capable of locating the DIP waterline.

2. If the wire will not pass current testing, locate the break in the circuit and repair and test until tracer wire works in accordance with its intended use.

D. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, for soil compaction testing requirements and specifications.

END OF SECTION

SECTION 02230

WATERLINE APPURTENANCES

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for waterline appurtenances such as valves, fire hydrants and fire sprinkler lines, used in potable water distribution systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of waterline appurtenances in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All waterline appurtenances materials shall be furnished complete with all gaskets, lubricants, fittings, bolts, nuts, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All fire protection and fire hydrant requirements are subject to approval by the Windsor-Severance Fire Protection District (W-SFPD).

B. All fire hydrants shall be Dry-Barrel fire hydrants, and shall conform to AWWA C502.

C. All gate valves shall be Resilient Seated gate valves and shall be manufactured and tested in accordance with AWWA C509.

D. All butterfly valves shall be Rubber Seated butterfly valves and shall be manufactured and tested in accordance with AWWA C504.

E. Construction Staking. Offset staking for both vertical and horizontal control shall be provided for all waterline appurtenances, per these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All fire hydrants and valves shall be new and supplied by one manufacturer.

B. Fire Hydrants.

1. Fire hydrants shall be handled, stored, and protected in such a manner as to prevent damage to materials, coatings, and finishes.

2. All fittings and joints shall be kept free from dirt, oil, and grease.

C. Valves.

1. Precautions shall be taken to prevent damage to materials during delivery and storage.

2. Store valves off the ground and away from materials that could contaminate potable water systems.

3. Seal valve ends to prevent entry of foreign materials into valve body.

4. Take precautions to keep joints and internal parts clean.

PART 2 – MATERIALS

2.1 FIRE HYDRANTS

A. All fire hydrants shall be manufactured in accordance with AWWA C502 and shall be dry-barrel (self-draining) fire hydrants with a compression valve opening size of five and one quarter (5¼″) inch.

B. All fire hydrants shall be designed for a working pressure of two hundred (200 psi) pounds per square inch.

C. Fire hydrants shall be three-way; two (2) hose (two and one half (2½″) inch) brass nozzles and one (1) pumper (four and one half (4½″) inch) brass nozzle. All threads shall be National Standard Thread and shall open left-handed, or counterclockwise (CCW). Nozzle covers shall have the same size and shape nut as the operating nut. Nozzle caps shall have a synthetic rubber gasket installed in a retaining groove and shall be attached to the fire hydrant with non-kinking type steel chains.

D. The operating nut shall be one and five sixteenths (1 5/16″) inch pentagon, opening counterclockwise (CCW). The word “OPEN” and an arrow showing the hydrant opens left shall be embossed on each fire hydrant.

E. The fire hydrant shoe shall have a mechanical joint fitting with the tee-head bolt and hexagon nut made of “Cor-Ten” steel, or approved equal, and shall be properly restrained or thrust blocked.

F. All fire hydrants shall have a frangible section near the ground line designed to break away on impact. The traffic breakaway feature shall be incorporated into the barrel of each hydrant and shall be six to ten (6″ - 10″) inches above finished grade.

G. Barrel extensions.

1. No more than one (1) six (6″) inch, twelve (12″) inch, or eighteen (18″) inch hydrant extension section may be used.

2. The extension manufacturer shall be the same as the fire hydrant manufacturer.

3. Where extensions greater than eighteen (18″) inches are necessary, a grade adjustment fitting shall be used.

H. Fire hydrant branch lines shall be six (6″) inch diameter, either PVC or DIP, utilizing six (6″) inch mechanical joint connections complete with a six (6″) inch resilient seat gate valve with a swivel tee or a hydrant tee on the branch waterline. The branch line between the hydrant and valve shall be at least three (3′) feet long and the valve shall be installed with a valve box.

I. All fire hydrant leads shall have a minimum of five (5′) feet of cover from top of pipe to finish grade elevation. If the operating nut on the auxiliary gate valve is more than six (6′) feet below finish grade, a riser stem shall be used.

J. All joints on the branch line from the main waterline to the fire hydrant shall be restrained per approved methods as described in these specifications.

K. All fire hydrants shall be factory coated with enamel; red in color. Field painting will be necessary in the event of scraping and chipping of the factory paint.

L. Acceptable manufacturers for fire hydrants are:

1. Mueller Centurion.

2. Waterous "Pacer", Model No. WB-67.

3. No substitutions allowed.

M. The DIP branch line, and all fittings, from the fire hydrant base, up to and including the tee, shall be encased in polyethylene wrap. See **Section 02224, Ductile Iron Pipe (DIP)**, of these Construction Specifications, for acceptable materials and methods of installation.

N. Fire hydrant drain gravel shall be one and one half (1½″) inch washed rock.

2.2 FIRE SPRINKLER LINES

A. Fire sprinkler lines three (3″) inches or smaller shall be type "K" copper.

B. Fire sprinkler lines larger than three (3″) inches in diameter shall be restrained ductile iron (DIP) pipe only. Restrained DIP fire sprinkler lines require concrete thrust blocking at the main. Sizes for fire sprinkler lines shall be approved by the Town Engineer and the W-SFPD.

C. Fire sprinkler lines shall have gate valves of an equivalent diameter, placed at the main. Unless otherwise required by the Town Engineer, these gate valves shall be mechanical joint (MJ) valves and fasten to a mechanical joint (MJ) anchor tee (swivel tee) on the main and shall be installed with a screw type, adjustable valve box with cap stamped "FIRE".

D. Fire sprinkler lines are not required to be metered; however, they shall have a backflow preventer and a detector check approved by the Town Engineer and/or the Town Water Department.

E. The DIP fire sprinkler line, and all fittings, from the building, up to and including the valve and tee, shall be encased in polyethylene wrap. See **Section 02224, Ductile Iron Pipe (DIP)**, of these Construction Specifications, for acceptable materials and methods of installation.

2.3 VALVES - GENERAL

A. All valves shall be new, non-rising-stem, threaded to open counterclockwise (CCW), or left, and shall be supplied with mechanical restrained joints (MJ).

B. All valves shall be capable of satisfactory operation with flow in either direction and shall be suitable for frequent operation and/or long periods of inactivity.

C. The operating pressure for all valves shall be designed at a minimum of two hundred (200 psi) pounds per square inch, and a test pressure of four hundred (400 psi) pounds per square inch, unless specified otherwise or as required by the Town Engineer.

D. Valves and flanges shall be a minimum of Class 150, unless otherwise specified.

E. The components of the mechanical joint shall conform to AWWA C111. The tee-head bolts and hexagon nuts shall be fabricated from a high-strength, low alloy steel that conforms to 315 SST bolts, "Cor-Ten" steel, or approved equivalent**.**

F. Valves placed in vaults shall have a valve operator (mechanical or otherwise) approved by the Town Engineer.

G. All buried valves shall be encased in polyethylene wrap. See **Section 02224, Ductile Iron Pipe (DIP)**, of these Construction Specifications, for acceptable materials and methods of installation.

2.4 GATE VALVES

A. Gate valves shall be used on all waterlines of six through twelve (6″ - 12″) inch, manufactured in accordance with AWWA C509, and shall be of the same size as the main waterline.

B. All gate valves, in accordance with AWWA C550, shall have a ductile iron body, coated both inside and outside with a tough, durable, fusion bonded epoxy, to prevent corrosion, fully bronze mounted with non-rising stems and resilient seats.

C. Valve bonnet bolts and nuts shall be high strength, 316 Stainless Steel. Buried gate valves shall have a two (2″) inch square operating nut, which shall have an arrow showing the direction of opening and the word "OPEN" cast on the nut and painted black. The stem seal shall consist of two (2) O-rings, in conformance with Section 4 of AWWA C509, one or both positioned above the thrust collar with the valve under pressure in the full open position.

D. Acceptable manufacturers for gate valves are:

1. Mueller.
2. Waterous.
3. American AVK.
4. Clow.
5. Kennedy.
6. M&H.
7. or approved equal.

E. The operating nut on all gate valves shall be between four to six (4′ - 6′) feet below finish grade. See Standard Details. If required, to achieve this operating nut depth, use a riser stem. Riser stem shall be a solid stem coated to prevent corrosion and shall have a centering plate to keep it centered within the valve box assembly.

F. Two (2) sets of manufacturer certified Shop drawings for each valve size shall be furnished to the Town for review and acceptance prior to start of construction.

2.5 BUTTERFLY VALVES

A. Butterfly valves shall be used on all waterlines greater than twelve (12″) inches in diameter, manufactured in accordance with AWWA C504, and shall be of the same size as the main waterline.

B. Butterfly valves shall be geared, designed for direct bury, and shall be a tight closing rubber seat type with the seats bonded to the body. No metal to metal surfaces is permitted.

C. All butterfly valves, shall be coated both inside and outside with a tough, durable, fusion bonded epoxy, to prevent corrosion.

D. All flanged butterfly valves, shall be the short body type.

E. All butterfly valves shall be Class 150B.

F. The operator torque shall be as specified in AWWA C504, Appendix A.

G. All butterfly valves shall be provided with mechanical joint connections unless otherwise specified.

H. For buried service, butterfly valves shall have a two (2″) inch operating nut. For exposed service, operator shall be a handwheel with enclosed gears, closing clockwise, or to the right, and having a position indicator, unless otherwise specified.

I. Position:

1. For use in horizontal position.

2. Operator horizontal to valve.

J. Acceptable manufacturers for butterfly valves are:

1. Mueller.

2. Pratt.

3. M&H.

4. or approved equal.

K. Engineer may require butterfly valves to be installed in a vault. Butterfly valves larger than fourteen (14″) inches must be installed in a vault, unless specifically directed otherwise by the Town Engineer.

2.6 TAPPING VALVES

A. A tapping valve and sleeve are used together to tap an existing waterline that is in service and under pressure, without interrupting service. Exercise care in selecting sleeves and gaskets which are properly sized to fit the type and class of pipe to be tapped.

B. All tapping valves shall be resilient seat type and manufactured in accordance with AWWA C509.

C. All tapping valves shall be provided with two (2) O-ring type stem seals, in accordance with Section 4 of AWWA C509.

D. Shall be equipped with an alignment ring on the flanged side of the valve and be equipped with a test plug.

E. Tapping sleeves for polyvinyl chloride (PVC) pipe and ductile iron pipe (DIP) shall have a stainless steel body. Tapping sleeves for existing waterlines consisting of other materials shall be as directed by the Town Engineer.

F. Accepted manufacturers are:

1. ROMAC.

2. Ford.

3. Smith Blair.

4. JCM Industries, Inc.

5. Or approved equivalent.

G. Tapping sleeves shall be rated at two hundred (200 psi) pounds per square inch, minimum, working pressure.

H. Tapping sleeves shall provide a one hundred (100%) percent leak-tight seal.

I. Prior to the Contractor ordering tapping sleeves, manufacturer's shop drawings and specifications shall be submitted to the Town Engineer for review and acceptance.

2.7 VALVE BOXES

A. Valve boxes shall be cast iron or ductile iron, buffalo type, two (2) piece boxes with round bases.

1. Valve boxes shall have a five and one quarter (5¼″) inch screw type shaft suitable for depth of cover as required. No slip-type boxes will be permitted.

2. Valve boxes shall be of a design, which will not transmit shock or stress to the valve and shall have enough extension capability to be raised to final street grade.

3. Valve boxes shall be capable of future adjustment for street overlays.

4. Valve boxes shall be a heavy duty cast with a total weight of no less than one hundred ten (110 lbs) pounds.

B. Valve box lids shall have the word "WATER" cast into the box lid for potable water and "IRR" for non-potable irrigation water and shall have a lip or flange extending into the valve box shaft. Valve box lids shall have the word "FIRE" cast into the box lid for fire sprinkler line valves.

C. All valve box sections and parts shall be uniform to one manufacturer per valve box installed.

D. Acceptable models and manufacturers for valve boxes are:

1. 6645, E.J.I.W.

2. 6645, Castings, Inc.

3. 6860 Series, Tyler.

4. 6645, Star Pipe.

5. M-9060/M-9064, D&L.

6. Or approved equal.

2.8 AIR RELIEF AND VACUUM RELIEF VALVES

A. Air release (ARV) valves, Air/Vacuum (AVV) valves, and combination air valves (CAV) shall be manufactured in accordance with AWWA C512.

B. ARV, AVV, and/or CAV (valves) shall be installed in manholes or vaults fitted with air vents open to the atmosphere. Vaults shall be in compliance with **Section 02280, Waterline Manholes and Vaults**, of these Construction Specifications.

C. ARV and AVV (valves) shall have an integral type assembly which will function both as air release and vacuum valve.

D. ARV and AVV (valves) shall be rated at a minimum working pressure of one hundred fifty (150 psi) pounds per square inch, and a minimum hydrostatic test pressure of two hundred fifty (250 psi) pounds per square inch.

E. The working parts and seats of ARV and AVV (valves) shall be brass, stainless steel, or other non-corroding material unless otherwise approved by the Town.

F. The body of all ARV and AVV (valves) shall be of either cast iron, conforming to ASTM A48-Class 35A, or ductile iron, conforming to ASTM A27-0GR U60-30, and shall be epoxy coated.

G. The float of ARV and AVV (valves) shall be of a non-corroding material.

H. All piping shall be brass.

I. Combination air valves (CAV) shall have features of both the ARV and AVV (valves).

J. The size of the ARV, AVV, or CAV (valves) shall be as noted on the approved Construction Drawings.

K. Acceptable manufacturers for ARV, AVV, and CAV valves are:

1. APCO Combination Air Release Valve, by Valve and Primer Corp.

2. A.R.I. Flow Control by A.R.I. Combination Air Valve.

3. Vent-O-Mat Series RBX, by International Valve Marketing, Inc.

4. or approved equal.

L. ARV, AVV, and CAV (valves) shall be watertight to a pressure of two hundred (200 psi) pounds per square inch.

2.9 PRESSURE REDUCING AND REGULATING VALVES

A. Pressure reducing and regulating (PRV) valves shall be of a type capable of maintaining pre-adjusted downstream pressures with varying rates of flow and upstream pressure without causing water hammer.

B. PRV (valves) shall be sized so that the velocity through the valve at maximum demand does not exceed twenty five (25 fps) feet per second.

C. PRV (valves) shall be installed in concrete valve vaults in accordance with **Section 02280, Waterline Manholes and Vaults**, of these Construction Specifications.

D. The PRV (valve) shall be hydraulically operated with a free floating guided piston having a seat diameter equal to the size of the valve.

E. PRV (valves) shall be of flanged, globe body, external pilot operated, piston type.

F. Flanges and covers shall conform to ASTM A126, Class B.

G. PRV (valves) shall be fully bronze-mounted with bronze castings of parts conforming to ASTM B62.

H. The PRV (valve) shall be furnished with flanged ends sized and drilled in accordance with ANSI/ASME B16.1 Class 125 Specifications. Flanges shall be machined to a flat face with a finish of two hundred fifty (250) micro inches, or machined to a flat surface with a serrated finish in accordance with AWWA C207.

I. All PRV (valves) shall be purchased from the manufacturer as an assembly and shall include a main valve, pilot valve system which controls operation of the main valve, and other operational components.

1. The pilot valve shall be single seated, diaphragm operated, spring loaded type.

2. The pilot valve shall be attached to the main valve with piping and isolation valves arranged for easy access to make adjustments and for its removal from the main valve while the main valve is under pressure.

3. An indicator rod shall be furnished as an integral part of the valve to show the position of the piston within the valve body. The valve shall be designed to provide an access opening in the valve body for removing the piston and other internal parts without removing the main valve body from the line.

4. The position indicator rod shall be firmly attached to the piston and passing through a stuffing box in the valve top for external, visual piston position indication. Furnish renewable leather cup power piston seals.

5. Telemetering of data may be required, as directed by the Town Engineer.

J. All PRV (valves) shall be rated a minimum working pressure of one hundred fifty (150 psi) pounds per square inch and a minimum hydrostatic test pressure of two hundred fifty (250 psi) pounds per square inch.

K. PRV (valves) shall be properly supported, and shall have sufficient room around the valve for assembly with adequate clearance above and below to make adjustments and to facilitate servicing.

L. A manual by-pass is required for all single valve installations.

M. A fire hydrant installation may be required in the immediate vicinity of the PRV for pressure testing purposes.

N. Each PRV (valve) shall have a gate valve on each side for isolation.

O. No dissimilar metals shall be allowed in the piping in PRV vaults without proper insulation.

P. Acceptable manufacturers for PRV valves are:

1. Cla-Val – 90-01.

2. or approved equal.

2.10 TRACER WIRE AND TEST STATION

Locator (tracer) wire and test stations shall be as specified in **Section 02220, Waterline Pipe Installation**, of these Construction Specifications.

2.11 POLYETHYLENE ENCASEMENT

Polyethylene encasement is required of all waterline appurtenances and shall be as specified herein and as specified in **Section 02220, Waterline Pipe Installation**, of these Construction Specifications.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine fire hydrants, valves, and other appurtenances, including associated valving and piping in assemblies, for cracks, dents, abrasions and other flaws.

B. Fire hydrants, valves, and other appurtenances shall be inspected and cleaned to ascertain that they are free of dirt or other foreign objects prior to installations. Valves shall be inspected in the open and closed positions to ensure that all parts are in working condition.

C. Gaskets. Gaskets shall at all times be protected from damage and contamination. Gaskets which display any imperfection in manufacturing, any damage, or any contamination shall not be used.

D. Damaged, flawed, or defective material shall be marked and removed from the construction site unless directed otherwise by the Town Engineer.

3.2 PLANNING AND PREPARATION

A. Valves, fire hydrants, and other appurtenances shall be installed at the locations shown on the final, approved Construction Drawings.

B. In anticipation of installation of waterline appurtenances, excavating for the trench, trench bottom stabilization, and proper bedding shall conform to the requirements specified in **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

C. Installation of waterline appurtenances shall, generally, be in conformance with that process specified in **Section 02220, Waterline Pipe Installation**, of these Construction Specifications. The joining of fire hydrants, valves, and other appurtenances shall be handled in the same manner as waterline pipe installation.

D. Adequate construction staking shall be provided to enable both vertical and horizontal control of appurtenances so that installation is accomplished accurately. Vertical staking shall be cut/fill stakes to the top of the fire hydrant body flange.

E. Field measurements of the actual location of appurtenances shall be made prior to backfilling for recording on the Project Record Drawings.

3.3 INSTALLATION

A. Fire Hydrants.

1. Fire hydrants shall be installed at the locations shown on the approved Construction Drawings.

2. All fire hydrants shall be installed at the proper elevation and set vertically plumb and be properly braced to insure against movement during backfilling operations. Install all fire hydrants with the hose nozzles parallel to the roadway and with the pumper nozzle facing the vehicle access, unless shown otherwise on the Construction Drawings or as directed by the Town Engineer.

3. Fire hydrants shall be set to the elevation staked, to insure that the bury line is at the final grade. The minimum depth of bury shall be five (5′) feet and the maximum depth of bury shall be six (6′) feet for restrained DIP fire hydrant laterals.

4. All fire hydrants shall be connected to the potable water distribution main by a six (6″) inch restrained DIP lateral (branch) line. Fire hydrant branch lines shall be a minimum of six (6″) inches in diameter and shall be set at ninety (90°) degrees to the street mains. No horizontal bends or offsets shall be used in installing fire hydrant branch lines. Under no circumstances shall a service tap be made on a fire hydrant branch line.

5. All fire hydrant branch lines shall have six (6″) inch mechanical joint connections complete with a six (6″) inch, resilient seat gate valve with a swivel tee or a hydrant tee on the main waterline in order that the hydrant may be removed from the system for maintenance without affecting the distribution system. The branch line between the hydrant and valve shall be at least three (3′) feet long and the valve shall be installed with a valve box.

6. Fire hydrants shall be of sufficient length so that the top of the fire hydrant shall be approximately three (3′) feet above the ground.

a. The vertical distance from any finished grade to the centerline of the hose nozzles shall not be less than eighteen (18″) inches or greater than twenty one (21″) inches.

b. If raising of a fire hydrant is necessary, no more than one (1) six (6″) inch, one (1) twelve (12″) inch, or one (1) eighteen (18″) inch extension section may be used. If the extension is greater than eighteen (18″) inches, a grade adjustment extension fitting shall be used, only upon approval of the Town Engineer.

c. Extensions shall be installed per manufacturer's recommendations.

d. Each fire hydrant extension installation shall be inspected by the Town.

7. All fire hydrants shall be supported on a minimum of eighteen (18″) of compacted hydrant gravel. Support fire hydrant with a concrete block.

8. All fire hydrants must be self-draining and the valve and stem must be capable of being withdrawn through the barrel. Fire hydrant drainage shall meet the following requirements:

   a. Fire hydrant drainage in pervious soils shall be provided at the base of the fire hydrant by placing coarse gravel or crushed stone (¾″ to 1½″) from the bottom of the trench to at least six (6″) inches above the waste opening in the fire hydrant and to a distance of one (1′) foot around the elbow.

   b. Fire hydrant drainage in clay or other impervious soils shall be provided at the base of the fire hydrant by a drainage pit two (2′) feet in diameter and three (3′) feet deep excavated below the fire hydrant and filled compactly with coarse gravel or crushed stone (¾″ to 1½″) under and around the elbow of the fire hydrant and to a level of at least six (6″) inches above the waste opening.

   c. All fire hydrant drains shall be placed around the shoe and drain of all fire hydrants and covered with two (2) layers of approved plastic (8 mil thick) to keep the voids between the stone open. A minimum of two (2 oz/sy) ounce per square yard filter fabric shall be placed around the sides and bottom of the rock drain.

   d. Fire hydrant drains shall not be connected to or located within ten (10′) feet of sanitary sewers or storm drains.

   e. Fire hydrant drain holes shall remain free of obstructions.

   f. Leave drain plug in place in high ground water conditions and note on Project Record (As-Built) Drawings.

9. All joints on the branch line from the main waterline to the fire hydrant shall be restrained per approved methods as described in these specifications. If, for some special reason and only upon approval of the Town Engineer, restrained joints for the fire hydrant assembly cannot be utilized, a concrete thrust block shall be placed behind the hydrant base (shoe) against undisturbed soil, with a minimum bearing surface area of four and one half (4½ ft^2) square feet.

   a. A sheet of eight (8) mil polyethylene film shall be placed between the fire hydrant shoe and concrete thrust block, extending up vertically to finish grade, encapsulating the hydrant barrel.

   b. After placing the concrete for the thrust block and ample time has passed for the concrete to cure, hydrant gravel shall be placed to a depth of twelve (12″) inches above the hydrant shoe. The concrete thrust block shall be allowed to cure sufficiently so that the drain gravel will not penetrate the concrete.

   c. Cover the gravel drain pit with filter fabric per these specifications.

d. Care shall be taken when placing concrete thrust blocks so that fire hydrant drain holes remain free of obstructions.

10. The ground surrounding the fire hydrant shall slope away from the hydrant at a minimum grade of two (2%) percent.

11. Location.

a. Fire hydrants shall not be placed in concrete sidewalks or pavement areas. Fire hydrants that must be placed in paved areas (only upon approval of the Town Engineer), shall maintain twelve (12″) inches of horizontal clearance between the concrete and the hydrant barrel. The twelve (12″) inch space between the concrete and the barrel shall be filled with drain gravel.

b. Fire hydrants shall be located at least one (1′) foot inside of the right-of-way line and shall conform to one of the following conditions:

i. When placed behind the curb when no sidewalk is to be installed, the hydrant barrel shall be set so that no portion of the pumper hose nozzle cap will be less than twenty four (24″) inches nor more than thirty (30″) inches horizontal distance from the gutter face of the curb.

ii. When placed in a landscaped area between the curb and the sidewalk or between the sidewalk and the right-of-way line, no portion of the hydrant nozzle cap shall be within six (6″) inches of the sidewalk or greater than eighteen (18″) inches from the sidewalk.

c. A three (3′) foot radius in all directions of the hydrant shall be clear of obstructions, which shall include, but is not limited to, posts, fencing, vehicles, trash, storage, shrubs, trees, or other plants with mature growth greater than one (1′) foot in height.

d. No permanent structure or obstruction shall be allowed within ten (10′) feet of the nearest edge of a fire hydrant. Shrubs and bushes (upon maturity) cannot be within five (5′) feet, and tree trunks (upon maturity) cannot be within ten (10′) feet of the nearest edge of a fire hydrant. No concrete surfaces shall be closer than one (1′) foot to a fire hydrant.

12. All Ductile Iron (DIP) pipe, fittings, fire hydrants, valves, and valve boxes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP)**, or AWWA C105-77, for further specification and instructions.

13. Tracer wire shall be installed along the fire hydrant branch line and into a test station behind every fire hydrant, in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

14. After fire hydrant installation is complete, the oil/grease reservoir shall be checked to ensure that it is full. If it is necessary to fill the reservoir, it shall be filled with the oil/grease specified by the hydrant manufacturer. Oil and grease shall be FDA approved. Grease the caps with FDA approved (food grade) grease.

15. Operation. Fire hydrants and associated valves which have been accepted by the Town shall be operated ONLY by Town personnel, unless otherwise authorized by the Town.

B. Fire Sprinkler Lines.

1. All fire sprinkler lines are subject to approval by the Town Engineer and the Windsor-Severance Fire Protection District (W-SFPD).

2. Fire sprinkler lines shall not be installed in trenches with other conduits/utilities.

3. No potable water service taps or irrigation service lines shall be made on a fire sprinkler line.

4. Fire sprinkler lines shall have separate, dedicated taps off the Town's water system main line. Fire sprinkler lines shall not be tapped off any portion of a domestic service line. Additionally, fire sprinkler lines shall not be tapped off any portion of a fire hydrant branch line. All fire sprinkler lines shall be located a minimum of five (5′) feet from any domestic service line.

5. Fire sprinkler line gate valves shall be placed at the main. Unless otherwise required by the Town Engineer, these gate valves shall be mechanical joint (MJ) valves and fasten to a mechanical joint (MJ) anchor tee (swivel tee) on the main and shall be installed with a screw type, adjustable valve box with cap stamped "FIRE".

6. Upon approval of the Town Engineer and/or Town Water Department, the backflow preventer and detector check shall be installed on the fire sprinkler line not within the Town's right-of-way. See these Construction Specifications, **Section 02220, Waterline Pipe Installation**, for additional specifications.

7. All Ductile Iron pipe (DIP), fittings, fire sprinkler lines, valves, and valve boxes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP)**, or AWWA C105-77, for further specification and instructions.

C. Valves.

1. Valves shall be installed in accordance with the manufacturer's recommendations and at the locations shown on the approved Construction Drawings.

2. With the exception of tapping valves, flanged valves shall not be buried.

3. Valves shall be installed in such a manner that the operating nut is perpendicular to the waterline pipe and can be easily operated from above ground.

4. Valves shall be adjusted to seat properly.

5. Valve operators which are mounted to one side of the valve shall be located to the south or west of the valve.

6. The mechanically joined valve shall be supported on compacted granular bedding material.

7. All Ductile Iron Pipe (DIP) valves, and valve boxes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP)**, or AWWA C105-77, for further specification and instructions.

8. Tracer wire shall be installed with the valve and into a test station behind every fire hydrant, in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

9. Reference Markers. Whenever a valve is located outside of a traveled street or walkway, or where adequate physical reference points are not available, a valve reference marker post shall be installed. The reference marker shall be a three (3″) inch galvanized pipe, filled with concrete. The pipe shall be painted with alternating stripes of yellow and silver each being four (4″) inches in width. The pipe shall have reflectors and reference information shall be painted on the reference marker, per the direction of the Town Engineer.

D. Tapping Valves.

1. Tapping valves shall be installed per the manufacturer's recommendations and only by an approved tapping service.

2. Tapping valves and sleeves shall be equipped with a threaded test hole and shall be installed such that the test hole is on top.

3. Prior to proceeding with the tap, tapping valves and sleeves/saddles shall be pressure tested to two hundred (200 psi) pounds per square inch, for ten (10 min) continuous minutes, with no visible leakage or loss of pressure.

4. A valve box shall be installed with the tapping valve.

5. All tapping valve installations shall require the installation of a concrete thrust block. See additional guidelines in **Section 02220, Waterline Pipe Installation**, of these Construction Specifications.

E. Valve Boxes.

1. All buried valves shall be provided with a valve box, including fire hydrant valves.

2. Valve boxes shall be installed so that no stress is transmitted to the valve or waterline.

3. Set the valve box plumb and centered directly over the valve's operating nut.

4. The backfill material around the valve box shall be carefully compacted around the barrel, with hand equipment, to minimize misalignment and settling of the backfill. Valve boxes which have shifted during backfill operations and are no longer plumb shall be re-excavated and realigned to the satisfaction of the Town Engineer. Special care shall be taken to ensure proper compaction around valve boxes. Compaction tests shall be required around all valve boxes.

5. All Ductile Iron Pipe (DIP) valve boxes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP)**, or AWWA C105-77, for further specification and instructions.

6. Tracer wire shall be installed with the valve and into a test station behind every fire hydrant, in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**. In exceptional cases, where approved by the Town Engineer, valve boxes may be used conjunctively as test stations. In this instance, the tracer wire shall be installed on the outside of the valve box, within twelve (12″) inches of the top of the box, then, through a drilled hole (sealed after installation), into the top of the box to eliminate twisting of the tracer wire when operating the valve.

7. All valve boxes shall be adjusted to within one quarter (¼″) inch of the finished elevation and grade of the street surface. A concrete collar shall be placed around the outside of the box at least one (1′) foot out from the box. See the **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02610**, **Manhole and Valve Box Adjustment**, for detailed specifications.

F. Air Relief and Vacuum Relief Valves.

1. Air release (ARV) valves, Air/Vacuum (AVV) valves, and Combination air valves (CAV) shall be installed at the locations shown on the approved Construction Drawings.

2. Where necessary, ARV, AVV, and/or CAV valves shall be installed at each high point in waterlines, where there is an abrupt change of slope, at line valves where the waterline slopes away from the valve, or as required by the Town Engineer.

3. Installation shall include gate valves (same size as the ARV or AVV valve) between saddle and air valve for maintenance purposes.

4. The inlet connection of ARV, AVV, and CAV valves shall be a minimum of two (2″) inches in diameter conforming to AWWA C800.

5. All ARV, AVV, and CAV valves shall be installed in pre-cast concrete manholes or vaults fitted with air vents open to the atmosphere. See these Construction Specifications, **Section 02280, Waterline Manholes and Vaults**, for additional specifications.

6. All ARV, AVV, and CAV valves shall be approved by the Town Engineer prior to installation. See **Section 1.05.A.3.** of these Specifications for additional information.

G. Pressure Reducing and Regulating Valves.

1. Pressure reducing and regulating (PRV) valves shall be installed at the locations shown on the approved Construction Drawings.

2. All PRV (valve) installations shall be designed by the Design Engineer and reviewed and approved by the Town Engineer prior to installation.

3. PRV (valves) shall be installed in concrete valve vaults in accordance with **Section 02280, Waterline Manholes and Vaults**, of these Construction Specifications.

4. PRV (valves) shall be properly supported, and shall have sufficient room around the valve in the vault for assembly with adequate clearance above and below to make adjustments and to facilitate servicing.

5. A manual by-pass is required for all single valve installations.

6. Install gate valves, sized the same as the waterline main, on each side of the PRV (valve) for isolation purposes.

7. No dissimilar metals shall be allowed in the piping in PRV vaults without proper insulation.

3.4 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J. and as modified herein:

A. Bacteriological Tests. Reference these Construction Specifications, **Section 02260, Waterline Disinfection**, for specifications and requirements.

B. Pipe Leakage Tests. Reference these Construction Specifications, **Section 02270, Hydrostatic Testing**, for directions and requirements.

C. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

D. Prior to Initial Acceptance, and pursuant to the Inspector's direction, fire hydrants with mars and/or scratches shall be "field" repainted using ONLY the manufacturer's specified paint.

E. After approved factory assembly, each valve shall be given operation and hydrostatic tests.

F. Operational Inspection. At the completion of the project, prior to Initial Acceptance, and in the presence of a Town representative, the Contractor shall operate all valves and fire hydrants to ascertain that the entire facility is in good working order, all valve boxes are centered and valves are open, all hydrants operate and drain properly, all curb boxes are plumb, centered, and water is available at all curb stops.

G. Valves and fire hydrants which have been accepted by the Town of Windsor shall ONLY be operated by Town personnel.

END OF SECTION

SECTION 02240

WATER SERVICE LINES

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for water service lines including corporation stops, curb stops, meter setters, meters, meter pits/vaults, and related appurtenances, used in potable water distribution systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of water services and appurtenances in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All water service lines and appurtenant materials shall be furnished complete with all gaskets, fittings, bolts, nuts, meter assemblies, pits, vaults, specials, and other accessories.

1.2 SCOPE

A. This section is a minimum guideline for the furnishing and installation of corporation stops, service lines, meters, meter setters, and meter pits.

B. Town owned service lines are from the waterline main to the curb box or meter pit.

C. All services shall be metered except fire sprinkler lines.

1.3 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All water service lines, tapping saddles, corporation stops, meters, and meter assemblies are subject to approval by the Town of Windsor Engineering Department and/or Water Department.

B. Construction Staking. Location staking for both vertical and horizontal control shall be provided for all waterline services, per **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

1.4 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All water service lines, tapping saddles, corporation stops, meters, and meter assemblies shall be new and shall be handled, stored and protected in a manner that will prevent damage to materials, coatings, and finishes.

B. All material shall be kept free from dirt, oil, and grease and any other source of contamination.

1.6 INSTALLATION OF SERVICE TAPS

A. No taps shall be made on any Town of Windsor waterline without prior permission from the Town.

B. Service taps on live mains shall be made only under the direct supervision of the Town. The Contractor shall coordinate with the Town Water Department and/or Engineering Department.

C. The Town reserves the right to make taps in lieu of the Contractor and the right to deny permission for any main to be tapped.

D. All water services one and one half (1½″) inch in diameter and larger, shall be fitted with an approved backflow prevention device.

1. Any case where a cross-connection potential exists, all taps must be fitted with a backflow prevention device.

2. Backflow prevention devices shall be installed according to the CDPHE, Water Quality Control Division's Cross-Connection Manual, latest edition, and tested upon installation and every year thereafter by a certified cross-connection control technician.

a. Product information sheets for proposed backflow prevention devices shall be submitted to the Town's Water Department for acceptance during the building review process and prior to requesting building permits.

b. Test reports shall be forwarded to the Water Department.

c. The Town Engineer and the Water Department reserves the right to enhance or expand upon the requirements of the CDPHE.

E. There shall be no physical connection between any potable water service line, inside or outside of any property or building, and any pipes, pumps hydrants, or tanks, whereby any unsafe or contaminated water (including steam condensation or cooling water) could be discharged or drawn into the potable water system.

F. Pressure reducing valves may be required according to the plumbing regulations.

G. No pressure booster system shall be allowed unless adequate backflow protection is used and only with written approval of the Town Engineer.

H. Reference **Section 1.05.I.**, **Backflow Prevention and Cross Connections**, of these specifications, for further information.

PART 2 – MATERIALS

2.1 TAPS AND SADDLES

The size of tap and the tapping method of a given type and size of water service line shall be as follows:

A. Size. Taps and service lines shall be of a size which is adequate to supply all the requirements of the property being served, while not being so large as to cause inaccuracies in metering low flows. The minimum size allowable for a service line shall be three quarter (¾″) inch.

B. Same Size. The tap, corporation stop, meter, and that portion of the service line between the meter and the corporation stop and five (5′) feet past the meter shall all be of the same size. The service line may be increased beginning five (5′) feet downstream of the meter to the next approved larger pipe diameter. In particular, to satisfy maximum pressure loss criteria, but not for the purpose of achieving greater flow using a smaller tap.

C. Velocity. Taps and services shall be sized to produce a water velocity no greater than ten (10 fps) feet per second at peak demand as estimated by an accredited "Fixture Unit" methodology. Additionally, the total pressure drop in the service line from the main to the building (including all minor losses) shall not

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exceed twenty five (25 psi) pounds per square inch without backflow prevention or thirty five (35 psi) pounds per square inch with backflow prevention and a minimum residual pressure of twenty (20 psi) pounds per square inch at the building beyond any backflow prevention under peak demand flow.

D. Minimum Tap Size. In addition to the above requirements, the minimum tap size shall also be based on the number of residential units allowed per tap as given in the following table:

Table 02240-1
Minimum Tap Size

TAP SIZE (inches)	UNITS ALLOWED PER TAP
¾″	1 to 2
1″	3 to 5
1½″	6 to 12
2″	13 to 30
3″	31 to 50
4″	51 to 100

E. Fixture Count. The estimates given in **Table 02240-1**, **Minimum Tap Size**, are for minimum estimated tap/service/meter sizing. Actual sizing should be based on flow calculated from an accredited "Fixture Count" methodology and varies dependent on the actual number of fixtures within each unit and within the overall building supplied. Tap size for over one hundred (100) units will be evaluated on an individual basis. In some circumstances the Town Engineer may require a larger minimum tap size.

F. Tapping Saddles.

1. Tapping saddles for three quarter (¾″) inch through two (2″) inch services shall be constructed of materials in accordance with one of the following descriptions:

   a. Ductile Iron Pipe (DIP) saddles shall have a brass or bronze body with double silicon bronze straps.

   b. Polyvinyl Chloride (PVC) pipe saddles shall have a brass or bronze body with double stainless steel straps.

   c. "Thread-O-Lets" may be used for weld-on tap saddles for steel pipe. "Thread-O-Let" saddle outlet threads shall be IP thread with insulated couplings. All other outlet threads on tapping saddles shall be "cc" type only.

   d. Nuts, bolts, and accessories shall be in accordance with the manufacturer's specifications.

   e. Inlets shall be threaded.

2. Three (3″) inch and larger taps on new waterline construction shall use tee fittings.

3. Three (3″) inch and larger taps on existing waterlines may be tapped only with approval from the Town Engineer.

   a. Tapping saddles shall be constructed with epoxy coated cast-iron or ductile iron or stainless steel flanges, attached to a full wrap stainless steel body with full wrap, totally confined end gaskets.

   b. Reference these Construction Specifications, **Section 02220, Waterline Appurtenances**, 2.6 – Tapping Valves, for additional specifications and requirements.

c. See **Section 1.05.G.**, Water Services and Meters, of these specifications, for further information.

4. Acceptable manufacturers of tapping saddles are:

a. Mueller.

b. Ford.

c. A.Y. McDonald.

d. Thread-O-Let.

e. Or approved equal.

2.2 CORPORATION STOPS

Corporation stops provide the connection for the service line to the main waterline. By utilizing a corporation stop, a service can be connected to the main without taking the main waterline out of service. Corporation stops used on all Town of Windsor waterlines shall meet the following criteria:

A. All corporation stops shall conform to AWWA C800 and be capable of operating at a working pressure of one hundred fifty (150 psi) pounds per square inch.

1. All corporation stops shall be full opening plug or ball type and constructed of brass.

2. Corporation stop inlet threads for tapping saddles shall be “cc” type only.

3. All corporation stop outlets shall use compression style connections, with a positive stop.

B. Corporation stops shall be used for all taps which are two (2″) inch and smaller.

C. Acceptable manufacturers of corporation stops are:

1. Mueller.

2. Ford.

3. A.Y. McDonald.

4. No substitutions allowed.

2.3 SERVICE LINES

Service lines shall be sized to adequately supply the requirements of the property being served. The minimum size line shall be three quarters (¾″) inch. A separate water service line and meter must serve each property; no compound water taps are allowed. Service lines shall not be constructed with galvanized pipe or plastic pipe.

A. Three (3″) inch and smaller service lines shall be copper and conform to AWWA C800, Appendix A.

1. The only acceptable material for copper services is seamless, Type “K” (soft) copper, conforming to ASTM B88.

2. No splices shall be allowed between corporation stop and meter yoke.

3. All connections shall be compression style only.

B. Four (4″) inch and larger service lines shall be ductile iron pipe (DIP) and conform to these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP).**

C. Fire sprinkler lines greater than three (3″) inch diameter shall be restrained ductile iron pipe (DIP) and conform to these Construction Specifications, **Section 02224, Ductile Iron Pipe (DIP)**. Three (3″) inch and smaller fire sprinkler lines shall be Type "K" copper and conform to these specifications. No potable water service taps shall be made on a fire sprinkler line.

D. Unless otherwise approved by the Town Engineer, there shall be no bends or changes in the size or material of the service line between the tap and a point five (5′) feet past the meter pit or vault for outdoor meter settings, or between the tap and a point five (5′) feet past the curb stop for indoor meter settings.

2.4 COUPLINGS

A. All couplings shall use compression style connections, with a positive stop.

B. All couplings shall be constructed of brass.

C. Acceptable couplings and their manufacturers are:

1. Mueller.

2. Ford.

3. A.Y. McDonald.

4. No substitutions allowed.

2.5 CURB STOPS

Curb stops are set on the service line near the property line and provide a means to shut off the service line. Curb stops used on all Town of Windsor waterlines shall conform to AWWA C800 and shall meet the following criteria:

A. Curb stops shall be used on water service lines which are two (2″) inches and smaller.

B. All curb stops shall use compression style connections, with a positive stop.

C. Curb stops may be either plug type or ball type, Minneapolis pattern, and shall be full opening.

D. All curb stops shall be constructed of brass.

E. Curb stops used on water service lines which are three (3″) inches and larger shall be gate valves and shall conform to these Construction Specifications, **Section 02230, Waterline Appurtenances**.

F. Acceptable curb stop manufacturer for water line services three quarter (¾″) inch through two (2″) inch are:

1. Mueller.

2. Ford.

3. A.Y. McDonald.

4. No substitutions allowed.

G. A curb stop valve of the same size as the water service line shall be installed on every service line between the main and the meter, unless noted otherwise on the approved Construction Drawings.

2.6 CURB STOP BOXES

A. Curb stop boxes are required with all curb stops.

B. Curb stop service boxes (or stop boxes) shall be cast iron, Minneapolis pattern.

C. The bottom part, shaped like an inverted "U" straddling the service line, shall have a flanged bottom so as to support itself.

D. Curb stop boxes shall have a one and one quarter (1¼″) inch telescoping upper section.

E. Curb stop box lids shall have a pentagon style access plug, with "WATER" cast into the lid.

F. Curb stop box shut-off rods shall be half (½″) inch stainless steel.

G. The maximum distance between the top of the lid and the shut-off rod shall be thirty (30″) inches.

H. Acceptable curb stop boxes and their manufacturers are:

1. Mueller: #H-10334 for three quarter (¾″) inch through two (2″) inch.

2. Ford: EA2-**-40-**R for three quarter (¾″) inch and one (1″) inch.
EA2-**-40-**R (with CB-7) for one and one half (1½″) inch and two (2″) inch.

3. A.Y. McDonald: 5607 (with 5607L) for three quarter (¾″) inch and one (1″) inch.
5602 (with 5607L) for one and one half (1½″) inch and two (2″) inch.

4. Or approved equal.

I. Curb stop boxes used on water service lines which are three (3″) inches and larger, and/or if the stop box is located in an area subject to traffic, street valve boxes shall be used and they shall conform to these Construction Specifications, **Section 02230, Waterline Appurtenances**.

2.7 METERS

A. All water meters, regardless of size, shall be purchased from the Town of Windsor Water Department. No exceptions.

B. All meters (interior and exterior settings) shall be equipped with Automatic Reading (AMR) devices of a type determined by the Water Department, to be installed in accordance with the Water Department's instructions in a location that will permit collection of a radio signal by the collection equipment.

C. Meters shall be of the same size as corporation stop or service tee and that portion of the service line between the meter and corporation stop. In no case shall a meter smaller than three quarter (¾″) inch be installed.

D. All three quarter (¾″) inch through two (2″) inch meters shall be displacement type meters and shall conform to AWWA C700.

E. All meters larger than two (2″) inches shall be compound meters and shall conform to AWWA C702.

1. External strainers shall be provided on all meters.

2. Turbine meters may be used in lieu of compound meters where specified or approved by the Town's Water Department. Turbine meters shall conform to AWWA C701.

F. The type and size of meter installed will be determined by the Town's Water Department at the time of application based upon demand, service requirements, location of meter and other conditions which may exist. The Town of Windsor Water Department may change the type of meter at any time based on the water usage patterns of the user.

2.8 METER SETTERS

A meter yoke (line setter) is a metal pipe frame attached to the inlet and outlet sides of the meter providing support, and conveying water to the meter. A meter yoke is required for displacement meters up through two (2″) inches, and may be required for other types or sizes of meters. The meter setter (yoke) shall be of an all copper and brass construction and will be supplied by the Town's Water Department.

A. To assure safety, the water meter setting shall provide a continuous, electrically conductive path around the water meter. If a bonding jumper is required, it shall be made of copper with fittings suitable for the bonding jumper and the water pipe material. The meter setting installation shall be in compliance with the NEC.

B. For meters in exterior, pit settings, all three quarter (¾″) inch and one (1″) inch meter setters shall have an angle ball valve with a padlock wing located on the inlet side, vertical inlet and outlet connections, and a seven (7″) inch height on three quarter (¾″) inch setters, and ten (10″) inch height on one (1″) inch setters with positive stop compression style lower connections in accordance with the manufacturer's accessory options.

C. For interior meter settings, all three quarter (¾″) inch and one (1″) inch meter setters shall have resilient seat ball valves with a padlock wing located before and after the yoke, vertical inlet and outlet connections, and a seven (7″) inch height on three quarter (¾″) inch setters, and ten (10″) inch height on one (1″) inch setters with positive stop compression style connections in accordance with the manufacturer's accessory options.

D. All one and one half (1½″) inch and two (2″) inch meter setters shall have an angle ball valve with a padlock wing, and a built-in locking by-pass in accordance with the manufacturer's accessory options.

E. The meter setter distance from the inside flange to flange shall be:

1. For a three quarter (¾″) inch meter = seven and one half (7½″) inch opening distance.

2. For a one (1″) inch meter = ten and three quarter (10¾″) inch opening distance.

3. For a one and one half (1½″) inch meter = thirteen and one quarter (13¼″) inch opening distance.

4. For a two (2″) inch meter = seventeen and one quarter (17¼″) inch opening distance.

2.9 METER PITS AND VAULTS

A. Meter setters for three quarter and one (¾″ & 1″) inch meters shall be installed in meter pits (supplied by the Town's Water Department) meeting the following requirements:

1. Meter pits shall be twenty four (24″) inches in diameter, a minimum of forty eight (48″) inches in height, and shall be constructed of a composite material such as rigid High Density Polyethylene (HDPE) with a dome or bell housing holding an internal frost lid and a locking top lid.

2. The base unit shall have two (2) "doghouse" cutouts three (3″) inches wide by four (4″) inches high, located one hundred eighty (180°) degrees apart to accommodate the service line piping.

3. The top unit shall have a shelf or tapered design to support a standard dome or bell housing.

4. An aluminum or cast iron dome or bell housing shall be mounted on the top of the pit. The dome or bell housing shall have a support for an interior frost lid and a rim for locking the meter pit cover. Cast iron domes are required in locations where the meter pit may be subject to occasional traffic loads. Composite or plastic domes are not permitted.

5. The meter pit covers shall be constructed of aluminum with cap type top lid and frost-proof rubber or plastic inner lid. The minimum allowable opening for meter pit covers shall be eleven (11″) inches.

6. Meter pit covers shall have "WATER METER" imprinted on the lid and shall have a worm–lock with a standard waterworks pentagon head.

7. The frost-proof rubber or plastic inner lid shall be dish shaped with a three (3″) inch depth and shall have three to five (3 – 5) drainage holes and an integral handle.

B. Meter setters for one and one half (1½″) inch and two (2″) inch meters shall be installed in concrete meter vaults meeting the following requirements:

1. Meter pits shall be forty eight (48″) inches in diameter and shall be constructed of precast concrete with an aluminum manhole ring and cover with locking nut.

2. The base unit shall have two (2) "doghouse" knockouts three (3″) inches wide by four (4″) inches high, located one hundred eighty (180°) degrees apart to accommodate the service line piping. Armor-flex tubing and grout shall be placed in the knockout prior to backfilling.

3. The top unit shall be a precast concrete flat top, designed for HS-20 loading and watertight.

4. All vault openings shall have modular sealing units and be grouted with non-shrink grout between the modular sealing unit and the vault inside and outside walls. All joints shall be watertight.

5. The meter vault covers shall be an aluminum manhole ring and cover with a twenty four (24″) inch diameter opening.

6. Meter vault covers shall have "WATER METER" cast in the lid and shall have a worm–lock with a standard waterworks pentagon head.

7. Reference Town of Windsor Standard Detail Drawings.

C. Meter setters for three (3″) inch and larger meters shall be installed in concrete meter vaults meeting the following requirements:

1. Water meter vaults for three (3″) inch and larger water meter installations shall be rectangular design and constructed of reinforced concrete.

2. The entry port through the top (or roof) of the vault shall be a hinged aluminum access door, located so that the center of the opening is over the water meter.

3. The top unit shall be a precast concrete flat top, designed for HS-20 loading and watertight.

4. All vault openings shall have modular sealing units and be grouted with non-shrink grout between the modular sealing unit and the vault inside and outside walls. All joints shall be watertight.

5. Meter vault access doors shall be aluminum, hinged access doors, "Bilco" or approved equal. See **Section 02280, Waterline Manholes and Vaults**, 2.5, Hinged Vault Access Doors, of these Construction Specifications, for further information.

6. Design Engineer shall submit a design for review and approval for this type of vault.

7. Reference Town of Windsor Standard Detail Drawings.

PART 3 – EXECUTION

3.1 GENERAL

A. Only those Contractors qualified to perform such work will be permitted to install water service connections within the Town of Windsor.

B. The Contractor shall make all taps on new waterlines, with approved equipment, and install the service line to the curb stop prior to disinfection and pressure testing of the water main.

C. The Contractor shall adjust curb stop boxes and meter pits to the horizontal location and to the final grade as determined by grade stakes set in the field.

1. Grade stakes shall be placed a minimum of five (5′) feet from the location of the meter pit.

2. Grade stakes shall not be disturbed prior to inspection of the service by the Town.

D. The Contractor shall mark the location of all water services in the following manner:

1. Place an imprinted "W", three (3″) inches high, into the face of the curb and gutter. See **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 03310, Curbs and Gutters**, Subsection 3.10.B.

2. Place a tee-post, painted blue, immediately in front of the curb stop box.

E. The Contractor shall mark the location of all fire sprinkler line services in the following manner:

1. Place an imprinted "F", three (3″) inches high, into the face of the curb and gutter. See **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 02595, Curbs and Gutters**, Subsection 3.10.B.

2. Place a tee-post, painted blue, immediately in front of the fire sprinkler line valve box.

F. Contractor shall inspect all tapping saddles, corporation stops, service lines, couplings, curb stops, curb stop boxes, meters, meter yokes (line setters), pits, vaults, and other appurtenances for cracks, dents, abrasions, damaged linings or coatings, or other flaws and ensure that they are free of dirt, grease, or other foreign objects prior to installation.

G. All potable water service lines shall be buried at least fifty four (54″) inches below the established grade of the street or ground.

3.2 PLANNING AND PREPARATION

A. In anticipation of water service line installation, excavating for the trench, trench bottom stabilization, and proper pipe bedding and backfill and compaction shall conform to the requirements as detailed in these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. Existing Utilities.

1. The horizontal and vertical location of existing utilities shall be field verified prior to start of water service line construction.

2. Any deviation in construction from what is shown on the approved Construction Drawings shall be reported to the Design Engineer and the Town Engineer immediately and documented on the "As-Constructed", Project Record Drawings.

C. Installation of water service lines and appurtenances shall, generally, be in conformance with that process specified in these Construction Specifications, **Section 02220, Waterline Pipe Installation**. The joining of corporation stops, curb stops, meter yokes, and other appurtenances shall be handled in a similar manner as waterline pipe installation.

D. Field measurements of the actual location of service lines and appurtenances shall be made prior to backfilling for recording on the As-Built Project Record Drawings.

3.3 SERVICE LINE TAPS

A. The Contractor shall not make taps on Town waterlines without permission from the Town Engineer and/or the Water Department.

B. The Town of Windsor reserves the right to deny permission for any waterline to be tapped.

C. No potable water service taps shall be made on a fire sprinkler line.

D. Taps shall not be made within two (2′) feet of any joint, fitting or valve.

E. Taps shall be separated by at least two (2′) feet, measured along the pipe length, even when taps are made on opposite sides of the pipe.

F. No more than four (4) service taps shall be permitted on any one (1) joint of pipe.

G. Water service taps within four (4′) feet cannot be in the same pipe quadrant.

H. Taps shall be made at the two (2:00) o'clock or ten (10:00) o'clock position on the pipe circumference.

I. Taps that are made on the same side of the pipe and within ten (10′) feet of each other, measured along the pipe length, shall be staggered by fifteen (15°) degrees.

J. Waterlines shall be tapped at a forty five (45°) degree angle from the horizontal centerline of the main on the same side of the pipe as the water meter.

K. Tapping certain waterlines may require digging out bedding material and cutting or removing part of the corrosion protective wrapping (polywrap). After the tap is made, the wrap shall be repaired or replaced by the Contractor in such a manner as to protect both the service pipe and the main.

L. Taps on waterlines shall be made only under the direct supervision of the Town. The contractor shall give forty eight (48 hrs) hours advance notice to the Town Water Department before any taps are made.

M. Tapping valves and sleeves shall be equipped with a threaded test hole and shall be installed such that the test hole is on top. Prior to proceeding with a wet tap on an existing waterline, tapping saddles shall be pressure tested to two hundred (200 psi) pounds per square inch, for ten (10 min) continuous minutes, with no visible leakage or loss of pressure.

N. Tapping equipment shall be of good quality, used for the purpose intended, and used in accordance with the manufacturer's instructions.

O. Corporation stops shall be installed by means of a tapping saddle in accordance with these specifications and the manufacturer's recommendations, unless otherwise indicated on the Construction Drawings, specified otherwise herein, or as directed by the Town Engineer or the Town's Water Department.

3.4 SERVICE LINES

A. Potable water service lines shall not be installed in trenches with other non-potable conduits/utilities. Water service lines shall be separated from other conduits a minimum of ten (10′) feet horizontally and eighteen (18″) inches vertically.

B. All service lines and fire sprinkler lines shall be a minimum of five (5′) feet and a maximum of six (6′) feet below the final grade.

C. That portion of the service line between the main waterline and the curb stop and/or meter when installed, shall be uniform in size, must be in a continuous straight line, with no joints and perpendicular, if possible, to the main.

D. No underground tees, connections, couplings, or joints are allowed in the copper service pipe three (3″) inches or less in diameter between the corporation stop and curb stop and/or meter. The use of underground joints may be allowed only on the repair of existing service lines with specific approval from the Town Engineer and/or Water Department. All couplings shall be compression by compression.

E. Care shall be taken to properly install water service lines so that enough slack is in the service lines to protect against pullout problems. An expansion loop near the tap shall not be installed higher than the top of the main being tapped. When backfilling the service trench, bedding shall be used under and six (6″) inches above the expansion loop at the connection to the main.

F. Service lines stubbed into the property line shall be of sufficient length to allow direct connection to the shut-off valve. A ten (10′) foot (minimum) pigtail shall be installed into the property from the curb stop.

G. A tee-post, painted blue, shall be placed immediately in front of the curb stop box.

H. When backfilling the service line trench, squeegee sand shall be used a minimum of six (6″) inches above and below the service line at any given location.

I. Water service line trenches shall be subject to compaction specifications. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

J. Where a water service line crosses another utility or any underground structure, the service shall preferably pass above the other utility or structure.

1. In no instance shall there be less than eighteen (18″) inches clearance between the water service line and any other utility or structure.

2. The space between the water service line and the other utility or structure shall be filled with compacted bedding material or flow-fill concrete.

3. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, for bedding and flow-fill material.

3.5 CURB STOPS

A. A curb stop or valve of the same size as the water service line shall be installed on every service line between the waterline main and the meter at plus or minus one (±1′) foot from the right-of-way line or easement boundary to provide a means to shut off the service line.

B. For outside meter settings, the curb stop should be placed within two to five (2′ - 5′) feet from the inlet side of the meter pit.

C. The curb stop and box shall be placed to produce the shortest possible length of service line between the corporation stop and the curb stop. Curb stops and boxes shall be located in landscaped areas and shall not be placed in driveways or sidewalks.

D. Where the curb stop must be placed beneath a paved surface, with the approval of the Town Engineer or Water Department, it shall be located where vehicles cannot park over it and not in the flow line of the street, and the stop box shall be a roadway valve box instead of the standard stop box.

E. The curb stop box shall be installed exactly centered over the curb stop valve and in a plumb, vertical position. The Contractor shall adjust the top lid of the curb stop box within one half to one (½″ - 1″) inch above the final grade prior to final inspections.

F. There shall be no major landscaping (trees, shrubs, boulders, etc.) or structures (retaining walls, etc.) within a five (5′) foot radius of the curb stop box.

G. There shall be no tees, connections, and/or couplings installed between the curb stop and the interior meter setter assembly.

3.6 METER PITS AND VAULTS

A. Meter pits and vaults shall be located as close as possible, but no closer than two (2′) feet, beyond the curb stop in a landscaped area.

B. Meter pits or vaults shall not be installed in any street, parking area, driveway, or sidewalk, unless prior written permission is obtained from the Town Engineer or Water Department. If a meter pit or vault is permitted to be located in any traffic area, the pit/vault shall be required to be designed and certified to withstand HS-20 traffic loading.

C. There shall be no major landscaping (trees, boulders, shrubs over three (3′) feet in mature height, etc.) or structures (retaining walls, etc.) within a ten (10′) foot radius of the meter pit or vault. All shrubs less than three (3′) feet in mature height shall be located no closer than five (5′) feet to a meter pit or vault.

D. All meter pits shall be constructed on a gravel draining base as detailed on the Town's Standard Detail Drawings unless directed otherwise.

E. The finished ground surrounding meter pits and/or vaults shall slope away from the lid at a minimum grade of two (2%) percent, toward the street.

F. There shall be no plumbing connections inside the meter pit or vault.

G. The Town of Windsor Water Department shall set all meters sized two (2″) inch or smaller. Larger meter sizes shall also be set by the Town's Water Department, with assistance from the Contractor.

H. All tees, connections, and couplings shall be a minimum five (5′) feet from the meter pit or vault wall, and shall be on the downstream (outlet) side.

I. The Contractor shall adjust the top lid of the meter pit or vault to the final grade as determined by the grade stakes. Grade stakes shall be placed a minimum of five (5′) feet from the location of the meter pit or vault. Contractor shall not disturb grade stakes prior to inspection of the service by the Town.

J. There shall be no tees, connections, and/or couplings installed between the curb stop and the interior meter setter assembly.

3.7 INTERIOR METER SETTINGS

A. No interior meter settings shall be permitted in a crawl space location. All buildings with crawl spaces shall have exterior meter settings with pits or vaults.

B. All interior meter setters shall be installed so that the meter is in a horizontal position.

C. The meter setter shall not be installed above a hot water heater.

D. A clear and unobstructed access of not less than thirty (30″) inches by thirty (30″) inches shall be provided so that the meter setter can easily be reached.

E. All tees and connections shall be at least two (2′) feet from the meter setter valve, on the downstream (outlet) side.

F. With the exception of the curb stop, there shall be no connections made between the main waterline and the meter setter.

3.8 FIELD QUALITY CONTROL

A. The Contractor shall ensure that the curb stop, corporation stop, and any couplings remain exposed until after inspection and the approval for backfill is given by the Town.

B. All tap and service inspections shall be scheduled with the Town a minimum of forty eight (48 hrs) hours prior to desired time of inspection.

C. The water shall be turned on at the curb stop by the Town, only after the service line, curb stop, stop box, and meter setter are installed and tested.

D. Meter pits and stop boxes shall be at finished grade at time of Initial Acceptance.

E. The Contractor shall demonstrate to the Town that the curb stops are operable prior to Initial Acceptance.

F. If the curb stop box or meter pit is damaged, bent, settled, or otherwise unacceptable to the Town, the Contractor/Owner shall be responsible for replacing/repairing the damaged stop box and/or meter pit prior to Initial Acceptance or the issuance of a Certificate of Occupancy, whichever is applicable.

G. The Contractor shall maintain and repair all service lines, meter pits, and any associated appurtenances which leak, were installed incorrectly, or otherwise prove to be defective, for a period of one (1 yr) year after final completion and acceptance of the work.

H. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, for soil compaction testing requirements and specifications over water service lines.

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SECTION 02260

WATERLINE DISINFECTION

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specifications and installation procedures for filling, disinfection, and flushing of waterlines, including their related appurtenances, such as valves, hydrants, fixtures, service lines, etc., used in potable water distribution systems within the Town of Windsor and include the acceptable materials and methods which may be used in the process of filling and disinfecting of waterlines and appurtenances.

The Contractor is responsible for the disinfection and testing of new or replacement waterlines.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. Standard: ANSI/AWWA B300, Hypochlorites, latest revision.

B. Standard: ANSI/AWWA C651, Disinfecting Water Mains, latest revision.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I., and as modified herein:

A. Contamination shall be considered as the presence of any visible foreign material that can come into contact with the potable water supply. Contamination shall include, but not be limited to: dust, debris, dirt, mud, including trench water, tools, clothing, rags, petroleum products, paint, pesticides, stones, animals, and insects, or other material, which shall not be permitted in the pipe. Precautions shall be taken to protect the interiors of pipes, fittings, fire hydrants, and valves against contamination during waterline installation.

B. Do not install waterline pipe when the trench contains water or when the trench bottom is unstable as determined by the Town Engineer. Water that is encountered in the trench shall be removed to prevent the entrance of water into the pipeline. The pipe shall not be used to dewater the trench.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D., and as modified herein:

A. Exercise extreme care in handling hypochlorites as they may be dangerous to health. Contractor is responsible for safety of all materials, equipment, personnel, and procedures for disinfection.

B. Light, heat, organic matter, and certain heavy metal cations such as copper, nickel, and cobalt accelerate the decomposition of hypochlorites. Dampness appreciably decreases the life of metal containers in which the powdered forms are shipped.

C. Hypochlorites should be stored in a cool, dry place, preferably in the dark. Store such that it is not possible for them to come in contact with other materials that are flammable, such as oil, grease, glycerin, or printed matter.

D. All hypochlorite solutions are corrosive to some degree, and will affect the skin and eyes upon contact. Any affected areas should be washed with copious amounts of water. When handling, due caution is advisable (wear gloves, aprons, goggles, and suitable vapor mask).

E. Reference AWWA B300 and AWWA C651, for further information.

PART 2 - MATERIALS

2.1 HYPOCHLORITE

A. Hypochlorite – Reference AWWA B300.

B. Hypochlorite for use in swimming pools is not allowed.

2.2 ADHESIVE

A. Adhesive for securing hypochlorite tablets to the interior of the pipe shall be a food grade adhesive, which has received USDA approval for uses that may involve contact with edible products.

B. Adhesives shall be certified to NSF Standard 61, prior to installation in the pipe.

C. Approved manufacturers of acceptable adhesives are:

1. Permatex No.1 for chlorine tablets.

2. Dow Corning 732 Multi-Purpose Sealant.

3. Or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor, with the Town's approval, shall satisfactorily disinfect, bacteriologic test, flush, and hydrostatic test new waterlines prior to placing them in service, in accordance with AWWA C651. Chlorination and bacteriological testing of the completed pipeline shall be done prior to the hydrostatic testing.

B. New waterline installations shall not be connected to existing waterlines until the new waterlines have been disinfected, flushed, tested, and accepted by the Town, unless granted approval otherwise by the Town Engineer.

C. All services (including saddle/sleeve, corporation stop/valve, service line, and curb stop) hydrants, valves, and all related appurtenances, shall be installed and approved by the Town prior to beginning the disinfection procedure.

D. All waterlines and appurtenances shall be disinfected, tested, flushed, and pressure tested after backfill operations have been completed and acceptable compaction test results have been submitted to the Town.

E. No waterline installation shall have been installed for more than ninety (90) calendar days prior to completion of disinfection testing.

3.2 PLANNING AND PREPARATION

A. Waterline installation shall be in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**, with particular attention paid to the provision for cleanliness within the pipe itself.

B. When waterlines are cut into or repaired, precautions shall be taken to avoid contamination. When isolation of a section of line is possible, the continuous feed or slug methods of chlorination shall be used, followed by thorough flushing as described below. If a waterline cannot be isolated or if it is required to minimize time that customers are without water service, the new pipe, fittings, and valves required for connection shall be spray-disinfected or swabbed with a minimum fifty (50 mg/l) milligrams per liter Hypochlorite solution. After the waterline has been repaired and flushed, Town personnel shall inspect the water for color, turbidity, and chlorine residual, prior to restoring the repaired waterline into service.

C. Filling the Pipe.

1. Only Town Water Department personnel shall operate existing Town owned valves to prevent the disinfecting solution from flowing back into the waterline supplying the water.

2. Where permanent air release vents are not available, the Contractor shall install corporation stops at high points in the waterline in order to evacuate trapped air.

   a. All corporation stops shall be installed using an approved tapping saddle. No direct taps will be allowed.

   b. All locations for corporation stops shall either be shown on the Town accepted Construction Drawings or as directed in the field by the Town.

   c. All corporation stops, which were installed to facilitate evacuation of air from the waterline shall be removed and plugged with a brass “cc” threaded plug (properly disinfected) after the waterline is filled, and pressure tested. All tap locations shall be shown on the As-Built Project Record Drawings.

3. Refer to specific method of disinfection for maximum filling velocity.

4. Water supplied from a temporary, backflow protected connection to the existing water distribution system or other approved supply source, shall flow at a constant measured rate into the newly installed waterline.

3.3 METHODS OF DISINFECTION

A. General.

1. The Town, together with the Contractor/Owner, in accordance with AWWA C651, shall determine the most appropriate chlorinating agent and method of application. The Town has the authority to restrict the method of disinfection on a case by case basis.

2. The Town’s Construction Inspector must be notified twenty four (24 hrs) hours in advance of filling the waterline.

3. The Town shall sample and test water from the pipe system extremities until clear, potable water is obtained. The Contractor shall reimburse the Town for all costs associated with follow up bacteriological water sampling due to failed potable water tests.

4. The Contractor shall properly and legally dispose of flushing and heavily chlorinated water.

5. All valves and other appurtenances shall be operated while the lines are filled with heavily chlorinated water to ensure total chlorination.

6. Prior to and during the disinfection process, valves shall be positioned so that the chlorine solution in the newly constructed main will not flow into water mains in active service.

B. Tablet/Granular Method.

1. The tablet/granular method consists of placing calcium hypochlorite granules or tablets in the waterline as it is being installed and then filling the main with potable water when installation is complete. This method of disinfection may only be used when contamination control (pipes and appurtenances kept clean) has been exercised during pipeline installation because the waterline cannot be flushed prior to chlorination. The tablet/granular method shall not be used when trench water or foreign materials have entered the waterline during construction or the temperature is below forty one (41° F) degrees Fahrenheit.

2. Placing Calcium Hypochlorite Granules.

   a. Calcium hypochlorite granules method may only be used with prior written approval by the Town.

   b. During construction, calcium hypochlorite granules shall be placed at the upstream end of each section of pipe and at the upstream end of each branch main.

   c. The quantity of granules used shall be as shown in Table 1, AWWA C651.

3. Placing Calcium Hypochlorite Tablets.

   a. During construction, calcium hypochlorite tablets (five (5 g) gram tablets) shall be placed in each section of pipe. Also, one (1) tablet shall be placed in each hydrant, hydrant branch, and other appurtenances.

   b. Tablets and/or granules shall be placed in sufficient number and amount to produce a minimum chlorine concentration in the treated water of fifty (50 mg/l) milligrams per liter.

   c. The minimum number of five (5 g) gram tablets required for each pipe section shall be as indicated in the following table:

Table 02260-1
Min. Number of 5g Hypochlorite Tablets
for a 50 mg/l dose

Pipe Section Length (ft)	Diameter of Pipe (inches)									
	6	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**	**36**
13 or less	2	2	4	5	7	8	11	13	18	41
18	2	3	5	7	9	12	14	18	25	56
20	2	4	5	7	10	13	16	20	28	63
30	3	5	8	11	15	19	24	29	42	94
40	4	7	10	14	19	25	32	39	56	125

For larger diameter pipes and/or longer pipe section lengths, the minimum number of five (5 g) gram calcium hypochlorite tablets for a fifty (50 mg/l) milligrams per liter dose can be calculated using the formula:

$$0.0024\ L\ d^2$$

rounded to the next highest integer, where d is the inside pipe diameter, in inches, and L is the length of the pipe section, in feet.

   d. Tablets shall be attached to the inside top of the pipe by a food-grade adhesive.

   e. The adhesive shall be only on the broadside of the tablet attached to the surface of the pipe.

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f. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on that pipe section to indicate that the pipe has been installed with the tablets at the top.

4. Filling and Contact.

a. Introduce water into the pipes at a velocity no greater than one (1 fps) foot per second with all fire hydrants and blow-off assemblies open.

b. The chlorinated water shall be retained in the lines for a minimum of forty eight (48 hrs) hours. If the water temperature is less than forty one (41° F) degrees Fahrenheit, the water shall remain in the pipe at least seventy two (72 hrs) hours.

c. After the required detention period has expired, the heavily chlorinated water in the pipeline shall be tested by a representative of the Town to ensure that a detectable chlorine residual of not less than twenty five (25 mg/l) milligrams per liter is found at each sampling point.

d. If the chlorine residual meets or exceeds the required minimum, the heavily chlorinated water shall be flushed from the system within a maximum of five (5) days, unless otherwise approved by the Town.

e. After the heavily chlorinated water has been thoroughly flushed, as described in the next section, hydrostatic testing shall be performed as described in these Construction Specifications, **SECTION 02270, HYDROSTATIC TESTING**.

C. Continuous-Feed Method.

1. The continuous-feed method of disinfecting waterlines consists of completely filling the main to remove all air pockets, flushing the completed waterline to remove the particulates, and filling the main with potable water. The flushing velocity shall not be less than two and one half (2½ fps) feet per second.

2. Chlorinated water shall be introduced into the waterlines at a point approved by the Town, but not more than ten (10′) feet downstream from the beginning of the new main. The chlorinated water shall enter the new main at a constant, measured rate so that the chlorine concentration is maintained at a minimum of twenty five (25 mg/l) milligrams per liter of free chlorine.

a. The entire main shall be filled with the chlorine solution.

b. Reference Table 4, AWWA C651 for required chlorine amounts.

c. Prior to and during the disinfection process, valves shall be positioned so that the chlorine solution in the newly constructed main will not flow into water mains in active service.

3. The chlorinated water shall be retained in the lines for a minimum of twenty four (24 hrs) hours, at which time the treated water in all portions of the main shall have a free chlorine residual of not less than ten (10 mg/l) milligrams per liter.

4. The continuous-feed method of disinfecting waterlines shall be used if it is necessary to flush the waterline prior to chlorination or for re-chlorination if the tablet/granular method fails.

D. Slug Method.

1. The slug method consists of placing calcium hypochlorite granules in the waterline during construction, completely filling the main to eliminate all air pockets, flushing the main to remove particulates, and slowly flowing through the main a slug of water dosed with chlorine to a concentration of one hundred (100 mg/l) milligrams per liter.

2. Refer to **Section 3.3.B.2** above, for placing calcium hypochlorite granules.

3. At a point approved by the Town, but not more than ten (10′) feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant, measured rate such that the chlorine concentration is not less than one hundred (100 mg/l) milligrams per liter of free chlorine.

4. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately one hundred (100 mg/l) milligrams per liter. All valves, fire hydrants, and blow-offs shall be operated as the slug passes to ensure total chlorination.

5. The free chlorine residual shall be measured in the slug as it moves through the main. If the free chlorine drops below fifty (50 mg/l) milligrams per liter, the flow shall be stopped, chlorination equipment moved to the head of the slug, and as flow resumes, chlorine shall be applied to restore the free chlorine in the slug to not less than one hundred (100 mg/l) milligrams per liter.

6. Flow rate shall be set so that all interior surfaces are exposed to a chlorine concentration of approximately one hundred (100 mg/l) milligrams per liter for a minimum of three (3 hrs) hours.

7. The slug method shall be used for large waterlines when continuous feed or tablet methods are not practical.

3.4 FINAL FLUSHING

A. After the applicable retention period, the water in the pipeline shall be tested to ensure a residual chlorine content of not less than twenty five (25 mg/l) milligrams per liter. Subsequent to achieving the required residual content and prior to performing the hydrostatic test, the heavily chlorinated water shall be flushed from the waterlines until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system, or is less than one (1 mg/l) milligram per liter.

B. Care shall be taken in flushing the pipeline to prevent property damage, danger to the public, erosion, or killing of desirable vegetation during the flushing. The Contractor shall be responsible for all necessary permits and to ensure that no environmental damage occurs. Reference Appendix B of AWWA C651, for a list of neutralizing chemicals. All discharges of water from blow-off assemblies or other appurtenances shall either be contained or discharged in a manner approved by the Town's Water Department or Town Engineer.

C. Waterlines shall be flushed at a velocity of at least two and one half (2½ fps) feet per second through the line. Flushing shall be performed after the tablet method but prior to the continuous feed method and the slug method. The Town's Construction Inspector must be notified twenty four (24 hrs) hours in advance of flushing. Flushing shall always be performed prior to pressure testing to expel all air from the line.

3.5 FIELD QUALITY CONTROL

A. A minimum of twenty four (24 hr) hours after flushing is completed, the Town shall collect water samples to test for bacteriological quality to show the absence of coliform and heterotrophic organisms in the waterlines. A minimum of two (2) samples will be collected and sent to Weld County Health Department for analysis.

1. The Town shall be given a minimum of forty eight (48 hrs) hours advance notice, prior to requesting sampling and shall schedule with the Contractor for sample collection locations and times, which shall be approved by the Town. Contractor shall provide all necessary devices and controls to enable sample collection by the Town.

2. Samples may only be taken Monday through Thursday, prior to two thirty (2:30) PM, per the Weld County Health Department requirements, exclusive of holidays.

B. The Town, based upon AWWA C651, shall determine the number, frequency, and location of samples.

C. Waterlines shall not be placed into service until written release is obtained from the Town.

3.6 REPETITION OF PROCEDURE

A. If the initial disinfection, or subsequent disinfections, fails to produce satisfactory samples, the main shall be re-flushed and re-sampled. If the samples are still not satisfactory, the continuous-feed or the slug method of chlorination shall be used to re-chlorinate the waterline until satisfactory results are obtained.

B. If the residual is less than twenty five (25 mg/l) milligrams per liter, the waterlines shall be re-chlorinated by the continuous-feed method and retested.

C. The Contractor shall reimburse the Town for all costs associated with follow up bacteriological water sampling due to failed potable water tests.

D. Waterlines shall not be placed into service until written release is obtained from the Town.

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SECTION 02270

HYDROSTATIC TESTING

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section addresses the procedures for hydrostatic (pressure) testing of potable waterlines, including fire hydrant branch lines, valves, water service lines, corporation stops, curb stops, and related appurtenances, used in potable water distribution systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the hydrostatic testing of potable water distribution systems.

The Contractor/Owner is responsible for the hydrostatic testing of waterlines and shall furnish all bulkheads, pumps, taps, meters, gauges, and appurtenances necessary for testing.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D.

PART 2 – MATERIALS

2.1 WATER FOR TESTING

A. Town of Windsor will only provide water for initial filling and testing of pipeline.

B. Contractor will provide water for additional testing. At the Town's discretion, if water is purchased from the Town, cost of water shall be at the standard bulk rate.

PART 3 – EXECUTION

3.1 PLANNING AND PREPARATION

A. Hydrostatic testing shall be conducted when:

1. Backfill and compaction has been completed and accepted by the Town, but before any street improvements are installed.

2. The waterline has been filled, disinfected, flushed, passed the bacteriological tests, and the Town has granted necessary approvals.

B. Contractor shall ensure that thrust blocking or other types of restraining systems will provide adequate restraint prior to pressurizing the system.

1. At least seven (7) days shall have elapsed since the last concrete thrust restraint was cast or until a minimum compressive strength of twenty five hundred (2500 psi) pounds per square inch is achieved.

2. A minimum of seventy two (72 hrs) hours shall elapse if high-early strength concrete is used.

C. Contractor shall provide all equipment and personnel to perform the hydrostatic test or obtain the services of an approved testing service to provide the testing.

1. Test equipment shall be able to maintain a continuous internal pipe pressure required for the test pressure specified, and accurately measure leakage from the pipe over a two (2 hr) hour, minimum, test period.

2. The maximum allowable pressure gauge increment shall be five (5 psi) pounds per square inch.

3. A water meter shall be used to measure the amount of water used in pressurizing the system.

D. Contractor shall disconnect all fixture devices and other accessories which may be damaged by the specified test pressure. Plug or cap ends as required.

E. Only the following methods are acceptable for supplying potable water for hydrostatic testing:

1. Water may be taken from a nearby pressurized water source which has been previously chlorinated, tested, and accepted, such as a fire hydrant.

2. Water may be delivered to the site in a State Licensed chlorinated water truck having a minimum capacity of three hundred (300 gal) gallons. The water truck shall be used exclusively for the transportation of potable water.

3. Any previously tested, chlorinated, and accepted water main, which is pressurized and is to serve the new waterline extension may be used only upon approval of the Town Engineer or Water Department.

4. Regardless, the method of supplying water as well as the source of water for hydrostatic testing must be certified and approved by the Town of Windsor. Use of barrels, sanitary or otherwise, to supply water for hydrostatic testing is strictly prohibited.

F. When existing waterlines are used to supply the test water, they shall be protected from backflow.

G. Testing against existing Town valves:

1. When testing against a closed valve connected to an existing potable water system, complete flushing and passing disinfection tests per these Construction Specifications, **Section 02260, Waterline Disinfection**.

2. Existing valves shall be examined and verified that no leakage is occurring. Replacement of existing valves with a new valve may be required as determined by the Town Engineer.

H. The Town shall be notified twenty four (24 hrs) hours in advance of testing and they shall witness all tests and either the Town, or the approved testing agency, or the Contractor will record times, leakage readings, and pressure over the test period on the Town's Hydrostatic Pressure Test Report form.

I. Unless directed otherwise by the Town, the hydrostatic pressure test shall be performed against all valves within the new distribution system, including connections to the existing system.

J. Only Town personnel shall operate existing Town owned valves.

K. Filling the line:

1. When filling the pipeline, it shall be filled at a rate which will not cause surges nor will it exceed the rate at which the air can be released.

2. Air in the line shall be properly purged. Where permanent air release vents or fire hydrants are not available or are not effective in purging air from the line, the Contractor shall install corporation stops at high points in the waterline in order to evacuate trapped air. The location and size of tap shall be at the Town's discretion.

3. All corporation stops shall be installed using an approved tapping saddle. No direct taps will be allowed.

4. All corporation stops, which were installed to facilitate evacuation of air from the waterline shall be removed and plugged with a brass "cc" threaded plug (properly disinfected) after the waterline is filled, and prior to pressure testing.

L. Pipe shall remain filled with chlorinated water for a minimum of twenty four (24 hrs) hours prior to the hydrostatic pressure test.

M. Prior to the tests, inspect valves within the test section to make sure they are fully operational.

N. Operate all valves in the system in the presence of Town personnel.

3.2 PRESSURE TEST

A. "Leakage" is the quantity of water that must be added to the pipeline, or any valve isolated section thereof, to maintain a pressure within five (5 psi) pounds per square inch of the specified test pressure after the air has been expelled and the pipe has been filled with water.

B. Test Pressure:

1. The hydrostatic test pressure, for DIP and PVC pipes, shall be two hundred (200 psi) pounds per square inch or one hundred fifty (150%) percent of the operating pressure, whichever is greater, at the highest point in the line or section under test.

2. A residual pressure, within five (5 psi) pounds per square inch of the test pressure, shall be maintained for a minimum of two (2 hrs) hours.

3. Test pressures shall be "running" pressures, constantly maintained by the test equipment. Static tests shall not be allowed.

C. The maximum allowable leakage for each test section is determined by the following formula:

$$\mathbf{L = \frac{NDH\sqrt{P}}{7{,}400}}$$

Where:
L = maximum allowable leakage, in gallons.
N = number of joints in section being tested.
D = nominal pipe diameter, in inches.
H = duration of test, in hours.
P = average test pressure during the leakage test, in psi (gauge).

For a test pressure of 200 psi at 2 hour duration, the maximum allowable leakage formula reduces to:

$$\mathbf{L = 0.00382ND}$$

There will be no additional leakage allowance for new valves.

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

E. Testing through fire hydrants shall not be allowed, unless specifically approved by the Town.

F. Testing and Leakage (Reference AWWA C600).

1. Unless prior permission is given by the Town, a test section shall not be any longer than the length of pipe between adjacent valves.

2. When testing against closed existing valves, an additional testing allowance per closed valve of 0.0078 gal/hour/inch of nominal valve size will be allowed.

3. No additional leakage allowance will be allowed for resilient seat valves.

4. When fire hydrants are in the test section, the test shall be made against the foot valve in the fire hydrant.

3.3 FIELD QUALITY CONTROL

A. If the tests disclose leakage greater than that specified, the defective materials and joints shall be located, repaired, and disinfected. The tests shall be repeated until the leakage is less than the maximum allowed.

B. With the exception of obvious leaks, passing of the pressure test shall be on the basis of maximum allowable leakage per section tested. No leakage is allowed through the bonnet of any valve or appurtenance. Any valve or appurtenance that is tested and leaks will be removed and replaced.

C. While the test pressure is maintained, an examination shall be made of the pipeline in general, and all visible leaks shall be repaired regardless of maximum allowable leakage.

D. If requested, the Contractor shall provide certification of meter accuracy.

END OF SECTION

SECTION 02280

WATERLINE MANHOLES AND VAULTS

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for waterline manholes and vaults for valves, meters, and other appurtenances used in potable water distribution systems within the Town of Windsor and includes acceptable materials and construction practices which may be used in the installation of manholes and vaults in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All waterline manholes and vaults shall be furnished complete with all steps, base and cone sections, seals, ring and covers, lids, vents, sumps, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D., and as modified herein:

A. Manholes and vaults shall be handled, stored, and protected in such a manner as to prevent damage to materials.

B. All joint surfaces shall be free from dirt, oil, and grease at the time of installation.

C. Flexible joint sealing compound materials shall be stored in a cool dry place to protect them from deterioration.

PART 2 – MATERIALS

2.1 PRECAST CONCRETE MANHOLES AND VAULTS

A. Precast concrete vaults and concrete manhole bases, risers, and cone sections for use on waterlines shall be manufactured in accordance with ASTM C478, and shall be made with Type II cement.

B. Concrete and Reinforcing Materials.

1. All concrete for manholes and vaults shall conform to these Construction Specifications, **Section 03340, Pre-Cast Concrete**.

2. All reinforcing materials shall conform to ASTM A615, A617, or ASTM A185.

C. Cones. All cones shall be eccentric.

D. No brick or CMU manholes or vaults will be permitted.

2.2 CAST-IN-PLACE CONCRETE VAULTS

A. Cast-in-place manholes will not be allowed. Vaults may be cast-in-place upon approval of the Town Engineer.

B. Cement used in cast-in-place concrete vaults shall conform to ASTM C150, Type II, and shall conform to these Construction Specifications, **Section 03310, Cast-in-Place Concrete**.

C. All fine and course aggregate shall conform to ASTM C33.

D. All deformed reinforcing bars shall conform to ASTM A615 or ASTM A617. All bars shall be either grade 40 or grade 60.

E. All welded wire fabric shall conform to ASTM A185.

F. Concrete used in cast-in-place vaults shall have a minimum of six (6) sacks per cubic yard.

1. Concrete shall have a maximum allowable water/cement ratio of 0.45, by weight.

2. Concrete shall develop a minimum compressive strength of thirty five hundred (3500 psi) pounds per square inch after twenty eight (28) days

G. Reference these Construction Specifications, **Section 03310, Cast-in-Place Concrete**.

2.3 MANHOLE STEPS

A. Manhole steps shall be corrosion resistant and shall be cast into the manhole wall at the time the manhole section is cast.

B. All steps shall be made of a minimum three eights (⅜″) inch diameter, grade 60, steel reinforcing rod completely encapsulated in a copolymer polypropylene plastic conforming to ASTM C478 and ASTM C497.

C. All steps shall be spaced twelve (12″) inches apart, on center, and in uniform alignment.

D. Manhole steps shall be no more than twenty four (24″) inches nor less than eighteen (18″) inches from the top of the manhole ring or from the bench of the manhole.

E. Manhole steps shall be located directly beside the valve operator.

2.4 RING AND COVER

A. All ring and covers for precast concrete manholes shall be ductile iron or aluminum material as specified herein.

1. For valve locations, the word “WATER” shall be cast into the cover.

2. Covers shall be non-perforated.

3. Ring and cover shall be heavy duty traffic lid and not rock under traffic conditions.

4. Pick-hole shall be one and one half (1½″) inch wide by one half (½″) inch deep.

5. Acceptable manufacturers of rings and covers are:

a. Neenah, R-1706.

b. Or approved equal.

B. All ring and covers for precast concrete vaults shall be aluminum material conforming to ASTM A36-93a.

1. For valve locations, the word “WATER” shall be cast into the cover.

2. For meter locations, the word “WATER METER” shall be cast into the cover.

3. Covers shall be non-perforated.

4. Meter vault covers shall have a worm-lock with a standard waterworks pentagon head.

2.5 HINGED VAULT ACCESS DOORS

A. Factory fabricated, hinged aluminum, floor doors for vault access shall be required on all Pressure Reducing Valve (PRV) concrete vaults, all Air Release Valve (ARV) and all Air Vacuum Valve (AVV) vaults, all water meter vaults three (3″) inch diameter and larger, all butterfly valve vaults, and where directed by the Town Engineer.

B. For PRV valves less than sixteen (16″) diameter, a double leaf, aluminum, diamond pattern, hinged door, measuring four (4′) foot by four (4′) foot entrance shall be used.

C. For PRV valves sixteen (16″) diameter and larger, one double leaf, aluminum, diamond pattern, hinged door, measuring four (4′) foot by four (4′) foot entrance shall be used directly over the valve and a single leaf, aluminum, diamond pattern, hinged door, measuring two and one half (2½′) foot by two and one half (2½′) foot entrance shall also be used.

D. For all other valve vaults, a double leaf, aluminum, diamond pattern, hinged door, shall be used. Opening size dimensions shall be as directed by the Town’s Water Department.

E. For water meters three (3″) inch diameter and larger, a double leaf, aluminum, diamond pattern, hinged door, shall be used. Opening size dimensions shall be as directed by the Town’s Water Department.

F. All factory fabricated, hinged, aluminum vault access doors shall meet the following requirements:

1. Cover: shall be one quarter (¼″) inch aluminum diamond pattern plate reinforced for one hundred fifty (150 psf) pounds per square foot live load.

2. Frame: shall be one quarter (¼″) inch extruded aluminum with strap anchors bolted to the exterior.

3. Hinges: shall be designed for horizontal installation and bolted to the underside of cover.

4. Lifting mechanisms: shall be cam-action hinges that pivot on torsion bars and act as a check to retard downward motion of cover when closing.

5. Latch: shall be stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle.

6. Lock: shall be a recessed padlock hasp covered by a flush hinged lid.

7. Finish: shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

G. Where hinged vault access doors might be subject to vehicular traffic conditions, this specification shall be altered to provide a reinforced door capable of withstanding AASHTO HS-20 loading.

H. Acceptable manufacturers of hinged, aluminum floor doors are:

1. The Bilco Co. – “Type K” and “Type KD” floor doors.

2. Or approved equal.

2.6 FLEXIBLE JOINT SEALING COMPOUND

A. A flexible joint sealing compound, or other approved plastic joint material shall be used in all concrete joints for manholes or vaults. Sealing compounds shall conform to Federal Specifications SS-S-00210 and shall remain pliable to negative twenty (-20° F) degrees Fahrenheit and shall not become excessively pliable at plus one hundred twenty (+120° F) degrees Fahrenheit.

B. Acceptable manufacturers of flexible joint sealing compounds are:

1. Hamilton-Kent Co. – “Kent-Seal No. 2”.

2. Or approved equal.

2.7 VENT PIPES

A. Vent pipes are used in vaults and pits to provide proper ventilation and shall be used where indicated on the approved Construction Drawings or as directed by the Town Engineer. Installations that contain electrical equipment shall have a locally controlled, power operated blower attached to the vent system.

B. Above ground vent pipes shall be six (6″) inch nominal diameter galvanized steel pipe, conforming to ASTM A53. The vent pipe shall terminate with a one hundred eighty (180°) degree elbow (pointing down) and screened with a three quarter (¾″) inch No. 9-11 flattened expanded galvanized metal screen.

C. Below ground vent pipes shall be six (6″) inch nominal diameter, schedule forty (40) PVC with glued joints. A PVC glued joint by standard pipe thread female adapter shall be used to connect the galvanized steel pipe to the PVC pipe at ground level.

2.8 SUMP PITS FOR VAULTS AND MANHOLES

A. Sumps are required for vaults or manholes in areas where there is seepage into existing vaults, all Pressure Regulating Valve (PRV) installations, and as determined by the Town Engineer.

B. Sump pit designs shall be prepared by the Design Engineer and reviewed and approved by the Town Engineer.

C. Sump pumps for discharge from the sump pit shall be required as indicated on the approved Construction Drawings.

D. Acceptable manufacturers of sump pumps are:

1. Zoeller Pump Co. – “Model 98”

2. Or approved equal.

E. Dehumidifiers for some vault installations shall be as indicated on the approved Construction Drawings and/or as determined by the Town Engineer.

PART 3 – EXECUTION

3.1 PLANNING AND PREPARATION

A. Precast concrete manholes and vaults shall be inspected for cracks, abrasions, or other flaws prior to installation. Damaged or flawed manholes or vaults shall be rejected and removed from the job site.

B. In anticipation of manhole and vault installation, excavating for the trench, trench bottom stabilization, and proper bedding and backfill and compaction shall conform to the requirements as detailed in these Construction Specifications, **Section 02210, Trenching, Backfill, and Compaction**.

C. Existing Utilities.

1. The horizontal and vertical location of existing utilities shall be field verified prior to start of water service line construction.

2. Any deviation in construction from what is shown on the approved Construction Drawings shall be reported to the Design Engineer and the Town Engineer immediately and documented on the "As-Constructed", Project Record Drawings.

D. Manholes and vaults shall be constructed in a manner as to allow operation of all valves from above the ground and, where required, shall be fitted with air vents open to the atmosphere.

E. All manholes and vaults shall be designed to adequately house the valves, meters, and/or fittings contained therein, as well as to withstand all external loadings imposed by earth, thrust, and AASHTO HS-20 highway live loading.

1. Manholes and vaults located in areas other than those that will involve vehicular traffic may be designed for a loading other than AASHTO HS-20, by the design engineer.

2. If the manhole or vault is not to be installed in a roadway, the roof shall be designed to support the overhead earth fill and any other reasonable loading that may occur.

3. Design calculations, drawings, and specifications shall be submitted to the Town Engineer for review.

F. Vaults shall be furnished with removable roof slabs to allow removal of all valves and fittings.

G. Manholes and vaults shall be sized so as to allow sufficient room for valve maintenance and minor repair and shall be furnished with rings and covers or hinged floor doors for easy access.

H. Vaults shall be constructed so that the vault opening opens directly over the meter, valve, or fitting.

I. The roof and walls of manholes and vaults shall be made waterproof after construction by use of sealants, epoxies, or other approved methods.

J. All manholes and vaults shall be designed with wall sleeves and approved seals at pipe penetrations and shall be capable of handling any thrust caused by removing valves.

3.2 INSTALLATION

A. Manholes and vaults shall be constructed at the locations and to the elevations indicated on the approved Construction Drawings.

B. When the overall height above the base of a manhole or vault is less than eight (8′) feet, a flat-top HS-20 top shall be required. Access holes for flat-top manhole installations shall be offset from center.

C. In accordance with these Construction Specifications, **Section 02210, Trenching, Backfill, and Compaction**, the trench shall be excavated to the proper depth, a minimum of eight (8″) inches below the bottom of the base of the manhole or vault. The bottom of the excavation shall be graded uniformly to provide a firm subgrade, suitable for placement of bedding material. If required, and as directed, stabilization material shall be imported and compacted prior to placing bedding.

1. Manhole and vault bases may be either precast or cast-in-place. Precast bases shall conform to C478. Cast-in-place bases shall conform with these Construction Specifications, **Section 03310, Cast-in-Place Concrete**. The minimum thickness of the base shall not be less than eight (8″) inches.

2. Certain meter and valve vaults may not require a concrete floor (as approved by the Town Engineer). These vaults shall be placed on an eight (8″) inch gravel bed composed of three quarter to one and one half (¾″ - 1½″) inch washed stone.

D. Manholes and vaults shall be set plumb and to design grade.

1. Precast concrete adjustment rings shall be used on top of the cone section to support and adjust the ring and cover to finish grade.

2. The total height from the top of the cone section to the finish street grade shall not exceed sixteen (16″) inches.

3. The adjustment rings shall be flush with the inside of the manhole.

E. Precast manhole and/or vault sections shall be joined to each other using a flexible joint sealing compound.

1. The application of the priming compound and the sealing compound shall be accomplished in strict conformance with the manufacturer's instructions.

2. The joint materials shall conform to the approximate manufactured shape at the time of installation and shall not be stretched or in any way distorted.

3. Base sections shall be joined to the cast-in-place base using a double row of flexible joint sealing compound on both interior and exterior shiplaps.

4. All joint surfaces shall be kept clean and dry during installation.

5. The joint between the manhole base section and the cast-in-place base shall be grouted on the inside to provide a smooth surface.

F. Concrete adjustment shims and ring and covers shall have a flexible joint sealing compound placed between each component.

G. All lifting holes, joints, and other imperfections shall be filled with an approved non-shrink grout, to provide a smooth finished appearance.

H. If the ground water level is normally above the bottom of the manhole or vault, the exterior surfaces of the manhole or vault shall receive a coating of tar at least one sixteenth (1/16″) inch thick. The determination of the need for a tar coating shall be made by the Town upon review of the soils report, or shall be as shown on the approved Construction Drawings. Buoyancy calculations shall be included with the design report from the Design Engineer.

I. Install vent pipes in vaults per the approved Construction Drawings. Vent pipes shall be field located at the nearest intersection of the property line and the side lot line.

J. Where required, sump pit designs for vaults or manholes shall be prepared by the Design Engineer and shall meet the following general guidelines:

1. Over-excavate the trench bottom three (3′) feet deep, approximately thirty (30″) inches in diameter in the lowest corner of the vault, but not open to the outside of the vault.

2. Install the precast six (6″) inch concrete floor, leaving an opening for the sump pit. Allow to set.

3. Cast-in-place a twenty four (24″) inch I.D., thirty (30″) inch O.D. sump pit with six (6″) thick floor.

4. A cast-in-place vault floor shall incorporate a monolithic sump pit.

K. Take special precautions to ensure sufficient compaction around manholes and vaults. Compaction tests are required around all manhole and vault installations.

L. All concrete work shall be protected from the weather and rapid loss of moisture and shall conform to **Section 03310, Cast-in-Place Concrete**, of these Construction Specifications. Concrete shall be protected from vehicular traffic for a period not less than seven (7) days or three (3) days with high/early or quick strength concretes.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C&J., and as modified in **Section 02210, Trenching, Backfill and Compaction**.

B. At least one (1) field moisture/density test shall be performed at every manhole and/or vault installation.

END OF SECTION

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SECTION 02420

SEWER LINE PIPE INSTALLATION

PART 1 – GENERAL

1.1 SCOPE

The work covered by this section includes materials specifications and installation procedures necessary for sanitary sewer pipe installation, including related appurtenances used in the sanitary sewer collection system within the public rights of way or public easements in the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of sanitary sewer pipe in accordance with these specifications and in conformity with lines, grades, typical sections, and details as shown on the approved Construction Drawings and/or as established in the field.

All sanitary sewer line installation shall be furnished complete including all labor, equipment, supplies, and materials.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C; and as modified herein:

A. Sewer line pipe installation shall conform to the regulations of the Colorado Department of Public Health, and the Water Quality Control Commission.

B. Sewer line pipe material shall be consistent for each size/diameter of pipe used throughout the entire portion of the project. Pipe material shall not be interchanged except where another type of pipe material is specifically indicated on the approved Construction Drawings and approved by the Town.

C. All materials used in the construction/installation of sanitary sewer pipes shall be new and free of defects.

D. Construction Staking.

1. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, for construction staking requirements.

2. The only acceptable method for verifying and confirming horizontal and vertical layout during installation of sanitary sewer lines shall be by calibrated/certified laser device.

3. Horizontal alignment shall not deviate from the approved Construction Drawings by more than one tenth (0.10′) foot.

4. Vertical alignment shall not deviate from the approved Construction Drawings by more than four hundredths (0.04′) foot, as measured from the top of pipe.

E. All sewer lines shall be installed in strict accordance with these specifications.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I., and as modified herein:

A. In order to prevent water, debris, and animals from entering the pipe, the open ends of the pipe shall be closed by a watertight plug installed when pipe laying is not in progress. If water is in the trench, the plug shall remain in place until the trench is pumped completely dry. All openings in the pipeline shall be

closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods.

B. Pipes shall be furnished with all necessary fittings, wyes, flanges, gaskets, lubricants, specials, and other accessories, as noted in these standards and shown on the approved Construction Drawings.

C. Use effective measures to prevent uplifting or floating of the pipeline prior to completion of backfilling operations.

D. Protect pipe and appurtenances against dropping and damage. Damaged pipe and appurtenances that are rejected shall be removed from the site.

E. Do not install sewer line pipe when the trench contains water or when the trench bottom is unstable as determined by the Town Engineer. Water that is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade, permit connection to be made in dry conditions, and to prevent the entrance of water into the pipeline.

1. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.

2. The excavation or trench shall be kept free from water until the structure or pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3. The pipe shall not be used to dewater the trench.

F. Do not install sewer line pipe when weather conditions are unsuitable. Approval from the Town is required when the temperature is thirty two (32° F) degrees Fahrenheit or less.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All materials shall be delivered to the construction site free of contamination. All materials shall be stored in a manner which will prevent contamination. Storage shall include protection from the weather at all times. To prevent contamination, materials shall be distributed along the project only to the extent that the materials will be installed on that same day.

B. Pipe and appurtenances shall be loaded and unloaded by lifting so as to avoid shock or damage. Under no circumstances shall such material be dropped. Use slings, pipe tongs, skids or other controlled methods for handling materials and equipment.

C. Care must be taken to prevent damage to materials and equipment by impact, bending, compression, abrasion or other deleterious handling. Contractor shall have proper implements, tools and facilities for the safe and convenient prosecution of the work.

D. Damaged materials and equipment shall not be installed and shall be repaired to the satisfaction of the Engineer, or removed from the construction site.

E. Before the placing of sewer line pipe in the trench, each pipe or appurtenance shall be thoroughly cleaned of all foreign material, kept clean at all times, and examined for cracks or defects before installation.

F. Joint lubricant shall be as supplied by the pipe manufacturer and shall not be stored or handled in a manner that will cause contamination.

G. Rubber gaskets shall be stored in a location that protects them from deterioration.

H. Store materials and equipment in accordance with the manufacturer's specifications.

I. Pipe, appurtenances, and joints shall be kept free from dirt, oil and grease and other sources of contamination.

PART 2 – MATERIALS

2.1 SANITARY SEWER LINE PIPE

A. Sanitary sewer line pipe material shall be Polyvinyl Chloride (PVC) SDR 35, non-pressure sewer pipe, conforming to ASTM D3034, suitable for sanitary sewer flows or, with prior approval, Ductile Iron (DIP) which shall conform to AWWA C151 and ASTM A746, shall be lined with a material that protects against damage from the effects of hydrogen sulfide (H_2S) (standard Cement Mortar Lining [CML] is not acceptable), and both shall conform to the requirements as detailed in these Construction Specifications, **Section 02422, PVC Non-Pressure Pipe** and **Section 02424, Ductile Iron (DIP) Gravity Sewer Pipe**, respectively.

B. Only approved materials may be used for sanitary sewer line pipes, but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septic conditions, temperature, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems. All sewers shall be designed to prevent damage from superimposed loads.

C. The same type of pipe material shall be used for each size pipe. Pipe material shall not be interchanged, except where another type of pipe material is specifically indicated on the approved Construction Drawings. When changes in pipe material are permitted, it shall occur from manhole to manhole.

D. Alternative pipe materials shall only be used upon approval of the Town Engineer and shall be used in the following situations:

1. Where sanitary sewer collection mains are installed less than four (4′) feet measured from the finished grade elevation to the top of the pipe, gravity sewer ductile iron pipe shall be used.

2. Where sanitary sewer collection mains are installed deeper than twenty (20′) feet at the invert, polyvinyl chloride (PVC) SDR 26 shall be used.

3. Where sanitary sewer collection mains are required to be encased for crossing purposes, polyvinyl chloride (PVC) pressure pipe, AWWA C900 or C905, might be used in lieu of encasement.

4. Where sanitary sewer collection mains are installed in bored casing pipes, if the joints are required to be restrained, gravity sewer ductile iron pipe with mechanical joints or polyvinyl chloride (PVC) pipe with mechanical joints shall be used.

2.2 SANITARY SEWER APPURTENANCES

The material for sanitary sewer appurtenances, such as wyes, fittings, underdrains, encasements, etc, shall conform to the requirements as detailed in these Construction Specifications, **Section 02430, Sanitary Sewer Appurtenances**.

2.3 PIPE JOINT LUBRICANT

Joint lubricant shall be as supplied by the pipe manufacturer, and approved by the Town Engineer. The lubricant shall not have deteriorating effects on the gasket material.

2.4 POLYETHYLENE ENCASEMENT

A. All buried ductile iron pipe (DIP) and fittings shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be eight (8) mil minimum thickness.

2.5 CONCRETE FOR ENCASEMENTS

Concrete to be utilized for encasements shall be six (6) sack concrete with a minimum compressive strength of three thousand five hundred (3,500 psi) pounds per square inch at twenty eight (28) days. See **1.08.C**, **Encasements and Borings**, of these Construction Specifications for additional information and details. Additional support may be required by the Town Engineer where large diameter lines cross. Minimum reinforcement shall be one of the following:

A. Number five (#5) rebar, continuous, placed at each corner of the encasement section tied with number three (#3) rebar at three (3′) foot centers.

B. Six by six (6x6) – W4 x W4 welded wire mesh with eight (8″) inch minimum lap, tied every twelve (12″) inches.

2.6 MANHOLES

See **Section 02450, Sanitary Sewer Manholes**, of these Construction Specifications, for information and details.

2.7 SANITARY SEWER SERVICE LINES

See **Section 02440, Sanitary Sewer Service Lines**, of these Construction Specifications, for information and details.

PART 3 – EXECUTION

3.1 INSPECTION

A. Pipe barrel and manholes shall be inspected and cleaned to ascertain that they are free of dirt or other foreign objects prior to installation.

B. Pipe, service wyes, and manholes shall be inspected for cracks, dents, abrasions, damaged linings or coatings, or other flaws prior to installation. Damaged or flawed pipe or appurtenances shall be rejected and removed from the construction site.

C. Gaskets. Gaskets shall at all times be protected from damage and contamination. Gaskets which display any imperfection in manufacturing, any damage, or any contamination shall not be used.

D. Operational Inspection. At the completion of the project and in the presence of a Town representative, and as required by the Town, the Contractor shall open all manholes and lamp all lines to ensure that no debris is left in the lines/manholes and the lines are not plugged.

3.2 PREPARATION

A. In anticipation of sewer line pipe installation, excavating for the trench, trench bottom stabilization, and proper pipe bedding shall conform to the requirements as detailed in **Section 02210, Trenching, Backfill and Compaction**.

B. Existing Utilities.

1. The horizontal and vertical location of existing utilities shall be field verified prior to start of sewer line construction.

2. Any deviation in construction from what is shown on the approved Construction Drawings shall be reported to the Design Engineer and the Town Engineer immediately and documented on the "As-Constructed", Project Record Drawings.

C. Underdrains.

If underdrain installation is required, and when approved by the Town Engineer, underdrains shall be installed ahead of the sanitary sewer installation.

3.3 CONNECTIONS TO EXISTING SEWER SYSTEM

A. Connections to the Town of Windsor's existing sanitary sewer collection system shall be made at an existing manhole or by setting a new manhole on the existing main. A watertight plug shall be installed in the new line to prevent any material from entering the existing system until the Town accepts the new sewer system.

B. At locations where a connection to an existing sanitary sewer collection main is to be made, the Contractor shall located the existing main both vertically and horizontally and verify its exact size and material prior to start of construction.

C. The Town's Sewer Department and/or Engineering Department personnel will examine the existing pipe or manhole. Any necessary adjustments in line, grade, or connection requirements to accomplish the connection shall be reviewed and accepted by the Town prior to making the connection.

3.4 PIPE INSTALLATION

A. The only acceptable method for verifying and confirming horizontal and vertical layout during installation of sanitary sewer lines shall be by calibrated/certified laser device.

B. Pipe Installation.

1. Pipe laying shall begin at the lowest elevation and shall be constructed continuously, proceeding upstream to the highest elevation, unless prior written approval is obtained from the Town Engineer and/or Sewer Department.

   a. Sanitary sewer pipe shall be installed so that the bell ends are pointing upstream.

   b. Lay pipe true to line and grade.

   c. Grade/pipe invert changes shall not be allowed within any run/reach between manholes.

   d. All sanitary sewer mains shall be installed with straight alignments between manholes. Joint deflection or bending of the barrel of the pipe shall not be allowed.

2. All pipe, fittings, wyes, and other appurtenances shall be carefully lowered into the prepared trench by means of a hoist, ropes, or other suitable tools or equipment in such a manner as to prevent damage to the materials and any protective coatings and linings. Nylon lift straps may be required at the direction of the Town Engineer. Under no circumstances shall sewer line materials be dropped or dumped into the trench.

3. No pipe or appurtenant structure shall be installed upon a foundation into which frost has penetrated or at any time when the Inspector deems there is a danger of ice formation or frost penetration at the bottom of the excavation. No pipe or related structure shall be installed unless backfilling can be completed before the formation of ice and frost.

4. Whenever necessary, sewer pipe shall be cut to conform to proper location of appurtenances, wyes, manhole connections, line, or grade. Cuts shall be straight and true, performed in a workman like manner without damaging the pipe or linings and so as to leave a smooth end at right angles to the

axis of the pipe. Burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed to create a beveled end in accordance with the manufacturer's recommendations. Tools used in cutting pipe should be designed specifically for the material and shall be approved by the Town Engineer. Flame cutting of pipe by means of an oxygen-acetylene torch shall not be allowed.

5. Immediately before joining two (2) lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. Caution shall be exercised to ensure that the correct type of gasket is used. If not previously installed by the manufacturer, the circular rubber gasket shall be flexed inward and inserted into the gasket recess of the bell socket. A thin film of approved gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe, per the manufacturer's recommendations. The lubricated joint shall be kept clean until joined.

6. The spigot end of the pipe shall be placed in the socket with care to prevent the joint from contacting the ground. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted. Care shall be taken so that the bell end of the pipe will not be deflected. The seating of the gasket shall be checked around the entire circumference of the pipe by visual and feeler gauge inspection. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint. Field-cut pipe lengths shall be filed or ground to resemble the spigot end of such pipe as manufactured. Previously completed joints shall not be disturbed during the jointing operation. Joints shall be watertight and free from leaks.

7. Complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. Make adjustments in line and grade by scraping away or filling pipe bedding under the entire length of the pipe, except at bells, and not by wedging, blocking, or mounding up the pipe or bells. The sewer line shall be installed so that a uniform grade is maintained between manholes.

8. Unless approved otherwise by the Town Engineer, horizontal pipe alignment(s) shall not deviate more than one tenth (0.10′) foot and vertical alignment(s) shall not deviate more than four hundredths (0.04′) foot from that shown on the approved Construction Drawings.

9. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints. Pipe shall be placed in such a manner that the specific bedding provides a solid uniform bearing surface for the full length of the barrel. Do not disturb the pipe after the jointing has been completed. Take effective measures to prevent opening of joints during bedding and backfilling operations.

10. Whenever the sewer line pipe is left unattended, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent children and animals from entering the pipe. All temporary plugs shall be approved by the Town Engineer. The plugging of pipe shall also apply to lunch breaks, as well as overnight.

11. All Ductile Iron pipe (DIP), fittings, and wyes shall be installed with an eight (8) mil polyethylene encasement. See these Construction Specifications, **Section 02424, Ductile Iron (DIP) Gravity Sewer Pipe**, or AWWA C105-77, for further specification and instructions.

12. Extra care should be used in handling Polyvinyl Chloride (PVC) Pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. See these Construction Specifications, **Section 02422, Polyvinyl Chloride Non-Pressure Pipe**, or AWWA C900-75, for further specification and instructions.

13. Backfill. The Contractor shall employ effective measures to prevent the separation of joints during jointing, bedding, and backfilling operations. Bedding material shall not be dropped onto unsupported pipe, which has been set to alignment and grade. Complete installation of bedding and backfill in accordance with these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

14. Depth of Bury. The minimum depth of cover shall be four (4′) feet from the finished grade to the top of the pipe, except as otherwise indicated on the Construction Drawings. The maximum depth of cover shall not exceed twenty (20′) feet from the finished grade to the top of the pipe, without further design calculations submitted by the Design Engineer and only as excepted otherwise when indicated on the Construction Drawings or as directed by the Town Engineer

3.5 MANHOLE INSTALLATION

A. See **Section 02450, Sanitary Sewer Manholes**, of these Construction Specifications, for information and details.

B. Sanitary Sewer Manholes shall be installed at the location and to the elevation shown on the approved Construction Drawings or as approved/directed by the Town Engineer and/or Sewer Department to accommodate field conditions.

C. Measurements of the actual location and elevation of sanitary sewer inverts and rim shall be made for the "As-Constructed", Project Record Drawings.

3.6 SANITARY SEWER SERVICE INSTALLATION

A. See **Section 02440, Sanitary Sewer Service Lines**, of these Construction Specifications, for information and details.

B. Sanitary Sewer services shall be installed at the location and to the elevation shown on the approved Construction Drawings or as approved/directed by the Town Engineer and/or Sewer Department to accommodate field conditions.

C. Measurements of the actual location and elevation of sanitary sewer service wyes and end caps shall be made for the "As-Constructed", Project Record Drawings.

3.7 PROTECTION OF METALLIC SURFACES

A. If the supplied material with metallic surfaces has not been factory coated, or the coating has been damaged prior to or during installation, the material may be protected by concrete encasement or the following method, only upon approval of the Town Engineer:

B. Ferrous metal rods, rebar, clamps, bolts, nuts, and other accessories which are subject to submergence or contact with earth or fill material, and not encased in concrete shall be protected with two (2) coats of coal tar enamel, or rubberized spray-on undercoating, or an approved equal, and wrapped with an eight (8) mil polyethylene film.

1. The first coat of coal tar enamel shall be applied to a dry, clean surface.

2. The first coat of coal tar enamel shall be allowed to dry before the second coat is applied.

3.8 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J; except subsection 1.3.J. shall be modified to include the following:

A. Pipe Testing. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for directions and requirements.

B. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

C. PVC Pipe. Reference these Construction Specifications, **Section 02422, Polyvinyl Chloride (PVC) Non-Pressure Pipe**, and/or AWWA C900-75, for further specification and information.

D. DIP Pipe. Reference these Construction Specifications, **Section 02424, Ductile Iron (DIP) Gravity Sewer Pipe**, and/or AWWA C104-74, for further specification and information.

E. Warranty Period. After the initial acceptance of the wastewater system, the Contractor shall be responsible for the repair of any leaks, infiltration or inflow, PVC pipe which shows excessive deflection, and any high spots or low spots resulting from improper workmanship or materials, discovered within the warranty period.

3.9 CLEANING

When all of the sanitary sewer pipes have been installed and backfilled, the line and manholes shall be cleaned and be free of sand, dirt, and debris. If the line must be flushed, it shall be done by the use of a high pressure jet or sewer balling method. Care shall be taken to ensure that no non-sewage water enters the existing sanitary system. Should the Contractor allow water to enter the existing system, damages to the system, costs of treating the water, and fines in accordance with the Town Code shall be at the Contractor's expense.

END OF SECTION

SECTION 02422

POLYVINYL CHLORIDE (PVC) NON-PRESSURE PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for polyvinyl chloride (PVC) non-pressure pipe for sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of plastic non-pressure pipe in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All PVC sewer line materials shall be furnished complete with all gaskets, fittings, wyes, lubricants, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C. and as modified herein:

A. Only approved materials may be used for sanitary sewer line pipes, but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septic conditions, temperature, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems. All sewers shall be designed to prevent damage from superimposed loads.

B. In general, selection of type of pipe shall be left to the discretion of the Professional Engineer in charge of design; however, the Town Engineer reserves the right to deny use of certain type of materials in specific circumstances.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All polyvinyl chloride (PVC) non-pressure sewer pipes shall be new and supplied by one manufacturer, unless directed otherwise by the Town Engineer.

B. Markings on Pipe.

1. All PVC sewer line pipe and fittings shall be marked by the manufacturer with the appropriate ASTM designations.

2. Any PVC pipe and fittings not properly marked will be rejected and removed from the job site.

3. All PVC materials shall be clearly marked on the exterior surface of the pipe with the following:

   a. ASTM designation.
   b. Size and Class.
   c. Date of Manufacture.
   d. Name and Trademark of Manufacturer.

C. Handling.

1. PVC pipe shall not be handled in a manner which will cause damage to the pipe.

2. Pipe shall be lifted with wide fabric lifting slings. Do not use hooks.

3. Do not drop pipe or fittings including dropping on cushions.

4. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.

5. Polyvinyl chloride (PVC) pipe flexibility is reduced along with impact resistance as temperatures approach freezing, which increases the need for additional care when handling and installing PVC pipe during cold weather.

D. Storage.

1. Pipe lubricants shall be stored and handled in a manner that will avoid contamination.

2. Rubber gaskets shall be stored in a cool, dark location which protects them from deterioration.

3. Pipe, gaskets, lubricants, and all other installation materials shall be stored in accordance with the manufacturer's specifications.

4. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell and shall be stored to prevent the pipe from deformation due to temperature fluctuations and stress fatigue.

5. Pipe which has a longitudinal deflection greater than one eighth (1/8 in/ft) inch per foot shall not be used.

6. Ultraviolet Deterioration.

a. No pipe stored outside and exposed to sunlight shall exceed the manufacturer's recommended exposure time. This time shall begin from the date of manufacture.

b. If the exposure time will be greater than the manufacturer's recommended time, or stored outside and exposed to sunlight for more than thirty (30) days, the pipe shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering.

c. Polyvinyl chloride (PVC) pipe that exhibits excessive ultraviolet deterioration and cracking, which in the opinion of the Town Engineer degrades the pipe quality, will not be permitted for installation and shall be removed from the job site.

PART 2 – MATERIALS

2.1 POLYVINYL CHLORIDE (PVC) NON-PRESSURE SEWER PIPE

A. All PVC non-pressure wastewater pipe and fittings shall be manufactured from components which conform to ASTM D1784, and shall be green in color.

B. Four (4″) inch through eighteen (18″) inch PVC non-pressure sewer pipe and all fittings shall have the same structural properties and shall be manufactured in accordance with ASTM D3034.

C. The diameter indicated on the approved Construction Drawings shall mean the nominal inside diameter of the pipe or fitting.

D. The standard dimension ratio (SDR) of PVC non-pressure sewer pipe shall not exceed thirty five (35).

E. Each length of pipe shall have a maximum laying length of twenty (20′) feet but shall be no shorter than twelve and one half (12½′) feet except at service wyes and when making closure connections to fittings.

2.2 JOINTS

A. All joints shall be of the push-on bell and spigot type and shall be manufactured in accordance with ASTM D3212.

B. All gaskets shall be of an o-ring type in accordance with ASTM F477.

C. Bells shall be formed integrally with the pipe and shall contain a factory installed elastomeric gasket, which is positively retained.

D. Only lubricant that is specified by the pipe manufacturer shall be used. Solvent cement joints are strictly prohibited.

2.3 SERVICE CONNECTIONS

A. All sewer fittings associated with the construction of new sewer pipe, including wyes, bends, risers, and plugs shall be manufactured of the same material, to the same specifications, and with the same specified joints as is the installed sewer main.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine PVC non-pressure sewer pipe and fittings and do not use sections containing: cracks, flaws, broken or loose lining, dents, and any abrasions.

B. In addition to any deficiencies covered by ASTM D3034, PVC non-pressure sewer pipe and fittings which has any of the following visual defects will not be accepted:

1. Straight pipe, measured from the concave side, shall not deviate from straight greater than one eighth (1/8 in/ft) inch per foot of pipe length.

2. Pipe which is sufficiently out-of-round to prohibit proper joining or be able to pass a mandrel test.

3. Improperly formed bell and spigot ends.

4. Fractured, cracked, chipped, dented, abrasioned, or otherwise damaged pipe.

5. Pipe or fittings that has been damaged during shipment or handling. Acceptance of the pipe at point of delivery will not relieve contractor of full responsibility for any defects in material of the completed sewer line.

C. Mark defective pipe or fitting and remove from the job site.

3.2 PREPARATION

A. For trenching, bedding, backfilling, and compaction, reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. All PVC sanitary sewer pipe shall be installed in full compliance with the Recommended Practice for "Underground Installation of Flexible Thermoplastic Sewer Pipe", ASTM Standard D2321.

C. Cutting the Pipe.

1. Cut pipe smooth, straight, and at right angles to the pipe axis with saws or pipe cutters designed specifically for the PVC pipe material.

2. Remove burrs and wipe off all dust from the jointing surfaces and inside pipe and fittings.

3. Bevel the cut end in accordance with manufacturer's recommendation.

4. Do not disturb previously installed joints during cutting operations.

D. Field Joints.

1. Use slip (push-on) joints for buried PVC sewer pipe except where indicated otherwise on the approved Construction Drawings.

2. Dirt, oil, grit, and other foreign material shall be removed from the inside of the bell and the outside of the spigot.

3. If gaskets are not previously inserted into the bell end of the pipe by the manufacturer, ensure that the correct type of gasket is used and flex the rubber gasket inward and insert into the gasket recess.

4. Apply a thin film of lubricant to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.

5. Keep the lubricated joint surfaces clean until joined.

3.3 INSTALLATION

A. For PVC pipe installation, reference these Construction Specifications, **Section 02420, Sewer Line Pipe Installation.**

B. PVC pipe shall not be installed when the air temperature or the soil temperature is thirty two (32° F) degrees Fahrenheit or less, unless otherwise approved by the Town Engineer.

C. No sanitary sewer pipe may be covered or backfilled until inspection of pipe and bedding has been made and the Town has given approval.

D. Joints.

1. PVC sewer line pipe shall be joined to the tolerances recommended by the manufacturer (*i.e*. the home line).

2. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted.

3. Adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. The sewer line shall be installed so that a uniform grade is maintained between manholes.

4. Previously completed joints shall not be disturbed during the jointing operation.

5. All joints shall be watertight and free from leaks.

6. Testing of all pipes under concrete and asphalt surfaces shall be performed prior to placing concrete or asphalt.

7. Support and block pipe as necessary to prevent flotation in high groundwater conditions.

E. Curves in Trench Alignment.

1. All sanitary sewer mains shall be installed with straight alignments between manholes. Joint deflection or bending of the barrel of the pipe shall not be allowed.

3.4 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J., and as modified herein:

A. Pipe Testing. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for pipe testing requirements and specifications.

B. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for soil compaction testing requirements and specifications.

END OF SECTION

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SECTION 02424

DUCTILE IRON (DIP) GRAVITY SEWER PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for ductile iron (DIP) gravity sewer pipe for sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of ductile iron gravity sewer pipe in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All DIP sewer line materials shall be furnished complete with all gaskets, fittings, saddles, lubricants, specials, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C. and as modified herein:

A. Only approved materials may be used for sanitary sewer line pipes, but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septic conditions, temperature, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems. All sewers shall be designed to prevent damage from superimposed loads.

B. In general, selection of type of pipe shall be left to the discretion of the Professional Engineer in charge of design; however, the Town Engineer reserves the right to deny use of certain type of materials in specific circumstances.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All ductile iron (DIP) gravity sewer pipe shall be new and supplied by one manufacturer, unless directed otherwise by the Town Engineer.

B. Markings on Pipe.

1. All DIP sewer line pipe and fittings shall be marked by the manufacturer with the appropriate ASTM designations.

2. Any DIP pipe and fittings not properly marked will be rejected and removed from the job site.

3. All DIP materials shall be clearly marked on the exterior surface of the pipe with the following:

   a. ASTM designation.
   b. Size and Class.
   c. Date of Manufacture.
   d. Name and Trademark of Manufacturer.
   e. Date of the lining system application and the numerical application sequence of that date.

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C. Handling.

1. DIP pipe shall not be handled in a manner which will cause damage to the pipe.

2. Pipe shall be lifted with slings, pipe tongs, or skids. Do not use hooks.

3. Do not drop pipe or fittings including dropping on cushions.

4. Do not skid or roll pipe into pipe already on the ground.

5. Do not damage pipe coating or lining.

6. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.

D. Storage.

1. Pipe lubricants shall be stored and handled in a manner that will avoid contamination.

2. Rubber gaskets shall be stored in a cool, dark location which protects them from deterioration.

3. Pipe, gaskets, lubricants, and all other installation materials shall be stored in accordance with the manufacturer's specifications.

4. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.

5. Do not exceed maximum stacking heights recommended by manufacturer.

PART 2 – MATERIALS

2.1 DUCTILE IRON (DIP) GRAVITY SEWER PIPE

A. Pipe.

1. All DIP gravity wastewater pipe and fittings shall be manufactured in accordance with AWWA C150 and AWWA C151.

2. The use of flanged gravity sewer DIP is not permitted.

3. The diameter indicated on the approved Construction Drawings shall mean the nominal inside diameter of the pipe or fitting.

4. Unless otherwise approved by the Town Engineer, gaskets and lubricants used with ductile iron gravity sewer pipe shall be as recommended and/or specified by the manufacturer.

5. The grade of iron used in the manufacture of ductile iron gravity sewer pipe shall have a minimum tensile strength of sixty thousand (60,000 psi) pounds per square inch, a minimum yield strength of forty two thousand (42,000 psi) pounds per square inch, and a minimum percent of elongation of ten (10%) percent (grade 60-42-10).

6. Gravity sewer DIP shall have a bituminous coating, minimum one (1) mil thickness, on the pipe exterior unless otherwise specified.

B. Lining.

1. Ductile iron gravity sewer pipe shall be lined with a material that protects against damage from the effects of hydrogen sulfide (H_2S). Standard cement mortar lining (CML) shall not be acceptable.

2. The lining shall cover all exposed pipe and/or fitting surfaces subject to contact with sewer liquid or gas.

3. Ductile iron (DIP) gravity sewer pipe shall be interior lined with PROTECTO 401™ Ceramic Epoxy (or approved equal), forty (40) mil nominal thickness, unless otherwise approved by the Town Engineer.

4. The lining material shall be amine cured, novalac epoxy containing at least twenty (20%) percent by volume of ceramic quartz pigment.

5. Due to the tolerances involved, the bell interior and spigot exterior, up to six (6″) inches back from the end of the spigot, must be coated with six (6) mils nominal, ten (10) mils maximum, PROTECTO Joint Compound.

6. The lining shall have a permeability rating of 0.00 when tested according to the procedure described in Method A, ASTM E96, Procedure A with a test duration of thirty (30) days.

7. The lining thickness shall be checked using a magnetic film thickness gauge. The thickness testing shall be performed using the method outlined in SSPC PA-2.

8. The interior lining shall be tested for pinholes with a nondestructive twenty five hundred (2500) volt test. Any defects found shall be repaired prior to shipment.

C. Ductile iron (DIP) gravity sewer pipe shall be furnished in normal laying lengths of either eighteen (18′) feet or twenty (20′) feet, except at service wyes and when making closure connections to fittings.

2.2 JOINTS

A. All joints shall be either of the “push-on single gasket” type slip joint, or the “mechanical single gasket” type, conforming to applicable requirements of AWWA C111.

B. The minimum grade of iron shall be grade 60-42-10.

C. All gaskets shall be of an o-ring type in accordance with ASTM.

D. Only lubricant that is specified by the pipe manufacturer shall be used.

E. When ductile iron gravity sewer pipe with mechanical joints is used, corrosion resistant, high strength, low-alloy, steel bolts and nuts shall be used where in contact with the soil, immersed, or in splash zones, in accordance with ASTM A325, type 3.

2.3 SERVICE CONNECTION

A. All sewer fittings associated with the construction of new sewer pipe, including wyes, bends, risers, and plugs shall be manufactured of the same material, to the same specifications, and with the same specified joints as is the installed sewer main.

2.4 POLYETHYLENE ENCASEMENT

A. All buried ductile iron (DIP) gravity sewer pipe and fittings shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be a minimum of eight (8) mil thickness.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine ductile iron (DIP) gravity sewer pipe and fittings and do not use sections containing: cracks, flaws, broken or loose lining, dents, and any abrasions or other defects.

B. Mark defective pipe or fitting and remove from the job site.

C. Ductile iron (DIP) gravity sewer pipe shall be marked with the date of the lining system application and the numerical application sequence of that date.

D. Pipe manufacturer must supply a certificate attesting to the fact that the lining application meets the requirements of this specification.

3.2 PREPARATION

A. For trenching, bedding, backfilling, and compaction, reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. Cutting the Pipe.

1. Cut pipe smooth, straight, and at right angles to the pipe axis with saws or pipe cutters designed specifically for the ductile iron (DIP) gravity sewer pipe material.

2. Remove burrs and wipe off all dust from the jointing surfaces and inside pipe and fittings.

3. Bevel the cut end in accordance with manufacturer's recommendation.

4. Do not disturb previously installed joints during cutting operations.

C. Field Joints.

1. Use slip (push-on) joints for buried ductile iron (DIP) gravity sewer pipe except where indicated otherwise on the approved Construction Drawings.

2. Dirt, oil, grit, and other foreign material shall be removed from the inside of the bell and the outside of the spigot.

3. If gaskets are not previously inserted into the bell end of the pipe by the manufacturer, ensure that the correct type of gasket is used and flex the rubber gasket inward and insert into the gasket recess.

4. Apply a thin film of lubricant to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.

5. Keep the lubricated joint surfaces clean until joined.

3.3 INSTALLATION

A. For ductile iron (DIP) gravity sewer pipe installation, reference these Construction Specifications, **Section 02420, Sewer Line Pipe Installation.**

B. No sanitary sewer pipe may be covered or backfilled until inspection of pipe and bedding has been made and the Town has given approval.

C. Joints.

1. Ductile iron (DIP) gravity sewer pipe shall be joined to the tolerances recommended by the manufacturer (*i.e*. the home line).

2. The joint shall then be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements, using approved methods of leverage. Stabbing the pipe shall not be permitted.

3. Adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. The sewer line shall be installed so that a uniform grade is maintained between manholes.

4. Previously completed joints shall not be disturbed during the jointing operation.

5. All joints shall be watertight and free from leaks.

6. Testing of all pipe under concrete and asphalt surfaces shall be performed prior to placing concrete or asphalt.

D. Polyethylene Encasement.

1. Polyethylene encasement is required at all buried ductile iron (DIP) gravity sewer pipe locations including fittings with mechanical joints.

2. Prior to installing polyethylene encasement, clumps of mud or other contaminants shall be brushed off the pipe or fitting surface.

3. Polyethylene encasement material shall be hand wrapped and installed in accordance with AWWA C105, Method A, latest revision.

4. Polyethylene encasement shall be so applied as to prevent the contact of backfill material with the ductile iron (DIP) gravity sewer pipe or fitting, but is not intended to be a completely airtight and/or watertight enclosure.

5. Maintain a solid encasement on ductile iron (DIP) gravity sewer pipe with the polyethylene. Tape to existing lines and the ends of encasement sections. Use pressure sensitive tape to close seams or hold overlaps.

6. Repair rips, punctures or other damage with adhesive tape or with a short length of polyethylene encasement wrapped around the pipe and secured in place

7. Prolonged exposure to sunlight will eventually deteriorate polyethylene film. Keep exposure to sunlight to a minimum.

E. Curves in Trench Alignment.

1. All sanitary sewer mains shall be installed with straight alignments between manholes. Joint deflection shall not be allowed.

3.4 SEALING FIELD CUTS AND REPAIRS

A. For cut pipe, smooth out the edge of the lining in a method approved by the manufacturer.

B. For damaged lining, remove any loose lining by chiseling, cutting, or scraping into well adhered lining before repairing the area.

C. An approved repairing compound shall be used for sealing and damage repairs. Compound shall be applied per manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J., and as modified herein:

A. Pipe Testing. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for pipe testing requirements and specifications.

B. Lining. The pipe manufacturer must supply a certificate attesting to the fact that the lining application meets the requirements of this specification.

C. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for soil compaction testing requirements and specifications.

END OF SECTION

SECTION 02430

SANITARY SEWER APPURTENANCES

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for sanitary sewer line appurtenances such as grease, sand, and oil interceptors, underdrains, and lift stations with force mains, used in sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of sewer line appurtenances in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All sewer line appurtenances materials shall be furnished complete with all gaskets, lubricants, fittings, bolts, nuts, specials, electrical devices, control panels, tracer wires, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All sanitary sewer appurtenances are subject to approval by the Town of Windsor Engineer.

B. All lift stations and force mains shall be subject to review and approval by the Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE – WQCD).

C. All grease trap and interceptor locations and design shall comply with the appropriate County Health Department rules and regulations and shall be in conformance with all applicable requirements of the Plumbing Code, as adopted by the Town.

D. Construction Staking. Offset staking for both vertical and horizontal control shall be provided for all sewer line appurtenances, per these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All sanitary sewer appurtenances shall be new and supplied by one manufacturer.

B. Lift Stations.

1. All lift station dry wells and wet wells shall be handled, stored, and protected in such a manner as to prevent damage to materials, coatings, finishes, equipment, controls, and piping.

2. All valves, fittings, joints, pumps, piping, and controls shall be kept free from dirt, oil, and grease.

PART 2 – MATERIALS

2.1 GREASE TRAPS AND INTERCEPTORS

A. All sand/oil and grease interceptors, although privately owned and maintained, shall be individually designed with materials, installation monitoring, and approval by the Town of Windsor, pursuant to the Town's Municipal Code, Title 13.

B. These appurtenances shall be installed in pre-cast concrete manholes or vaults, designed and sized individually for each case, by the Design Engineer, and shall meet the requirements of these Construction Specifications, **Section 02280, Waterline Manholes and Vaults**, and shall be properly vented.

C. Furnish with all accessories, including base and ring and cover. Covers shall be marked "SEWER".

D. Grease traps shall be constructed of either steel or cast iron and shall have a full gas-tight cover.

E. Interceptors shall provide the proper retention time and capacity for removing fats, oils and grease from the wastewater flows.

F. Interceptors shall have two (2) compartments; the smallest (outlet side) shall be at least one third (⅓) the capacity of the entire interceptor.

G. Water jacketed grease traps are not allowed.

H. Requirements for mortar, grout, preformed plastic gaskets, and other appurtenances shall be the same as for manholes. See these Construction Specifications, **Section 02450, Sanitary Sewer Manholes**.

2.2 UNDERDRAINS

A. Perforated and non-perforated underdrain pipe shall be polyvinyl chloride (PVC) pipe, SDR 35. See these Construction Specifications, **Section 02422, Polyvinyl Chloride (PVC) Non-Pressure Pipe**. Upon approval of the Town Engineer, underdrains may be ductile iron, pre-stressed concrete, or other suitable pipe material able to withstand underwater forces and resist buoyancy.

B. Screening chambers shall be provided at all points of intake to underdrain systems.

C. Where perforated underdrain pipes are approved, the perforations shall be half (½″) inch holes on five (5″) inch centers with two (2) rows parallel to the axis of the pipe and one hundred twenty (120°) degrees apart.

D. Flexible couplings are permissible on underdrain pipes. Acceptable manufacturers of flexible couplings are:

1. Dallas Specialty & Manufacturing Co. – Flexible Couplings.

2. Indiana Seal – Flexible Couplings.

3. Fernco – Flexible or Reducing Couplings.

4. Joints Inc. – Calder Coupling.

5. Mission Rubber Co. – Standard Bushing Coupling.

6. Or approved equal.

E. Perforated underdrain pipe shall be sleeved with a continuous, knitted polyester filter sock. An acceptable manufacturer of fabric filter socks is Carriff Corporation, Inc. – Drain-Sleeve®; or approved equal.

F. Underdrain cleanouts shall be installed in a street valve box. The valve box lid shall be marked "STORM". Cleanout pipe material shall be solvent welded polyvinyl chloride (PVC) SDR 35. Use pipe manufacturer's recommended primer and solvent for welded pipe joints.

2.3 LIFT STATIONS

A. Package pump stations with separate wet well, manufactured by Gorman Rupp, are the only standard accepted by the Town of Windsor.

B. The use of submersible sewage pumps or pneumatic ejectors is unacceptable.

C. The Town will require a basis of design to be submitted with the detailed plans and specifications for all lift stations. Discharging raw sewage into State waters is unacceptable under any circumstances.

D. Lift stations require site location and design review and approval from the Colorado Department of Public Health and Environment (CDPHE).

E. At least three (3) pumps shall be provided in each lift station. Pumps shall be capable of passing spheres of at least three (3″) inches in diameter.

F. All lift stations shall have suitable devices for measuring, recording, and totaling sewage flow and power consumption.

G. Alarm systems shall be provided on all lift stations with an autodialer and shall be telemetered over a dedicated radio wave to the Town's Sewer Department.

H. Electrical power supply shall be available from an independent generating source augmented with on-site emergency power equipment.

I. For further design information, reference **Section 1.08.L**, **Lift Stations and Force Mains**, and **Section 1.09.D**, **Lift Stations and Force Mains – Design**, of these Design Specifications.

2.4 FORCE MAINS

A. At a minimum, force main pipe material shall be AWWA C900 polyvinyl chloride (PVC) pipe, colored white, and shall comply with **Section 02222, Polyvinyl Chloride (PVC) Pipe**, of these Construction Specifications.

B. Ductile Iron (DIP) pressure pipe may be used for force mains, with approval from the Town Engineer. All DIP force mains shall be manufactured in accordance with AWWA C151, and shall comply with **Section 02224, Ductile Iron Pipe (DIP)**, of these Construction Specifications.

C. All Ductile Iron (DIP) Pipe and fittings shall be installed with an eight (8) mil polyethylene encasement. See **Section 02424, Ductile Iron (DIP) Gravity Sewer Pipe**, of these Construction Specifications, or AWWA C105-77, for further information.

D. The force main diameter and pipe material shall be selected by the Design Engineer for the specific situation; however, force mains shall not be less than six (6″) inch diameter.

E. Vaults and blow-off valves shall be installed at all "low points" in force mains. Manually operated air relief valves (ARV) shall be installed in force mains at "high points". All shall be individually marked with a green, Carsonite marker.

2.5 AIR RELIEF AND VACUUM RELIEF VALVES

A. Air release (ARV) valves, Air/Vacuum (AVV) valves, and combination air valves (CAV), for use on force mains, shall be manufactured in accordance with AWWA C512.

B. ARV, AVV, and/or CAV (valves) shall be installed in manholes or vaults fitted with air vents open to the atmosphere. Vaults shall be in compliance with **Section 02280, Waterline Manholes and Vaults**, of these Construction Specifications.

C. ARV and AVV (valves) shall have an integral type assembly which will function both as air release and vacuum valve.

D. ARV and AVV (valves) shall be rated at a minimum working pressure of one hundred fifty (150 psi) pounds per square inch, and a minimum hydrostatic test pressure of two hundred fifty (250 psi) pounds per square inch.

E. The working parts and seats of ARV and AVV (valves) shall be brass, stainless steel, or other non-corroding material unless otherwise approved by the Town.

F. The body of all ARV and AVV (valves) shall be of either cast iron, conforming to ASTM A48-Class 35A, or ductile iron, conforming to ASTM A27-0GR U60-30, and shall be epoxy coated.

G. The float of ARV and AVV (valves) shall be of a non-corroding material.

H. All piping shall be brass.

I. Combination air valves (CAV) shall have features of both the ARV and AVV (valves).

J. The size of the ARV, AVV, or CAV (valves) shall be as noted on the approved Construction Drawings.

K. Acceptable manufacturers for ARV, AVV, and CAV valves are:

1. APCO Combination Air Release Valve, by Valve and Primer Corp.

2. A.R.I. Flow Control by A.R.I. Combination Air Valve.

3. Vent-O-Mat Series RBX, by International Valve Marketing, Inc.

4. or approved equal.

L. ARV, AVV, and CAV (valves) shall be watertight to a pressure of two hundred (200 psi) pounds per square inch.

2.6 TRACER WIRE AND TEST STATION

A. Locator (tracer) wire shall be placed above all force mains and shall be copper wire, twelve (12 ga) AWG, solid wire, six hundred (600) volt, watertight insulation, Type UF, for direct bury.

B. Connectors shall be solderless, 3M direct bury splice kit, or approved equivalent.

C. Test Station shall be flush-to-grade type complete with insulated terminal block with four (4) terminals.

D. Test Station cover shall be lockable, cast-iron lid, with “SEWER TEST” cast in the cover.

E. Test Station section to be four (4″) inch inside diameter with a twelve to eighteen (12″ - 18″) inch long flared plastic shaft to prevent removal.

F. In some situations, where approved by the Town Engineer, a valve box may be used as the Test Station. The tracer wire should be run on the outside of the valve box up to a point twelve (12″) inches below finish grade and enter into the box at that elevation.

G. See **Section 02220 Waterline Pipe Installation**, of these Construction Specifications, for further information.

2.7 WARNING LOCATOR TAPE

A. Warning locator tape with "SEWER FORCE MAIN BURIED BELOW" printed on the tape shall be installed, on all force mains about eighteen (18″) inches above the top of the pipe.

B. At a minimum, locator tape shall be colored white, three (3″) inches wide, four (4) mils thickness, non-detectable polyethylene. The tape shall be solid colored with black letters.

2.8 POLYETHYLENE ENCASEMENT

A. All buried ductile iron pipe (DIP) and fittings shall be encased in polyethylene in accordance with AWWA C105, Method A.

B. Polyethylene encasement shall be eight (8) mil minimum thickness.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine vaults, grease traps, pipes, valves, pumps, controls, and other appurtenances, including associated valving and piping in assemblies, for cracks, dents, abrasions and other flaws.

B. Grease traps, underdrain pipes, pumps, valves, and other appurtenances shall be inspected and cleaned to ascertain that they are free of dirt or other foreign objects prior to installations. Valves shall be inspected in the open and closed positions to ensure that all parts are in working condition.

C. Gaskets. Gaskets shall at all times be protected from damage and contamination. Gaskets which display any imperfection in manufacturing, any damage, or any contamination shall not be used.

D. Damaged, flawed, or defective material shall be marked and removed from the construction site unless directed otherwise by the Town Engineer.

3.2 PLANNING AND PREPARATION

A. Grease traps, underdrains, lift stations and force mains, and other appurtenances shall be installed at the locations shown on the approved Construction Drawings.

B. In anticipation of installation of sewer line appurtenances, excavating for the trench, trench bottom stabilization, and proper bedding shall conform to the requirements specified in **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

C. Installation of sewer line appurtenances shall, generally, be in conformance with that process specified in **Section 02420, Sewer Line Pipe Installation**, of these Construction Specifications. The joining of piping, valves, vaults, wet well/dry wells, and other appurtenances shall be handled in the same manner as sewer line pipe installation.

D. Adequate construction staking shall be provided to enable both vertical and horizontal control of appurtenances so that installation is accomplished accurately. Vertical staking shall be cut/fill stakes to the invert of the sewer line (flowline).

E. Field measurements of the actual location of appurtenances shall be made prior to backfilling for recording on the "As-Constructed", Project Record Drawings.

3.3 INSTALLATION

A. Grease Traps and Interceptors.

1. Grease traps and interceptors shall be installed at the locations shown on the approved Construction Drawings or as directed by the Town's Sewer Department.

2. All grease traps and interceptors shall be installed at the proper elevation and set vertically plumb and shall be properly braced to insure against movement during backfilling operations.

3. Unless approved otherwise by the Town's Sewer Department, interceptor vaults shall be located external to the building being served. The interceptor shall also be situated upon the dedicated, platted lot for the building being served.

4. Grease traps and interceptors shall be set to the elevation staked, to insure that the invert elevation (flowline) is at the proper grade.

5. Grease traps shall comply with all requirements of the appropriate County Health Department, and shall conform to the requirements of the Plumbing Code, as adopted by the Town of Windsor.

    a. No more than four (4) fixtures shall be connected to a grease trap.

    b. Dishwashers shall not be connected to a grease trap.

    c. No food waste disposal unit shall be connected to a grease trap.

    d. An approved flow control or restrictor is required prior to the grease trap and must be accessible at all times for maintenance and examination.

    e. Grease traps shall be accessible at all times for maintenance and examination.

    f. Each grease trap and interceptor installation shall be inspected by the Town's Sewer Department.

6. All grease traps and interceptors shall be supported on a minimum of eight (8″) of compacted gravel.

7. Interceptor vaults shall be vented in accordance with the Town's current adopted Building and Plumbing Codes. See these Construction Specifications, **Section 02280, Waterline Manholes and Vaults**, for additional specifications.

8. Domestic wastewater shall not enter or flow through any portion of an interceptor. All domestic wastewater flows shall connect into a service line downstream of any interceptor.

9. The entire portion of each interceptor vault shall be accessible at all times for maintenance and inspection.

10. The ground surrounding grease traps and interceptors shall slope away from the unit to prevent inflow of storm runoff water.

11. Location.

    a. No permanent structure or obstruction shall be allowed within ten (10′) feet of the nearest edge of a grease trap or interceptor. Shrubs and bushes (upon maturity) cannot be within five (5′) feet, and tree trunks (upon maturity) cannot be within ten (10′) feet of the nearest edge of grease traps and/or interceptors Grease traps and interceptors shall not be placed in concrete sidewalks or areas of high foot traffic.

    b. A three (3′) foot radius in all directions of grease traps and interceptors shall be clear of obstructions, which shall include, but is not limited to, posts, fencing, vehicles, trash, storage, shrubs, trees, or other plants with mature growth greater than one (1′) foot in height.

12. Operation. Grease traps and interceptors and associated valves and piping which have been constructed and approved by the Town shall be shown to be operable and maintainable to the Town's Sewer Department.

B. Underdrains.

1. All underdrain pipe installations shall be in accordance with the recommendations of a Geotechnical Engineer and the approved Construction Drawings. Underdrains shall be designed to the have the same slope as the sanitary sewer main.

2. Underdrains **shall not** be connected to the sanitary sewer collection system nor shall they discharge onto the surface or to any other location not approved by the Town. Underdrains shall only discharge into approved discharge locations such as the storm drainage system or designed detention areas.

3. Street underdrains shall be non-perforated. Terminal ends of the street underdrain pipe shall be capped (plugged) with concrete.

4. Outside the street right-of-way or sanitary sewer easement, underdrains shall be perforated and sleeved with a geotextile, polyester, knitted sock.

5. Underdrain Pipe Laying.

   a. Underdrain pipe installation shall begin at the lowest elevation and proceed upstream to the highest, unless prior written approval is obtained from the Town.

   b. Underdrain pipes shall be installed so that the bells are pointing uphill.

   c. Street underdrains shall be installed beneath sanitary sewer manholes.

6. Underdrains shall be installed in the sanitary sewer collection main trench a minimum eight (8″) inches vertical clearance below the manhole base and a minimum eighteen (18″) inches horizontal clearance from the outside diameter of sanitary sewer pipe to the outside diameter underdrain pipe.

7. No underdrain pipe may be covered or backfilled until inspection of the pipe and bedding has been made or the Construction Inspector has given approval.

8. Where underdrain systems are required, groundwater barriers shall be installed ten (10′) feet upstream of sanitary sewer manholes and at the property line on sewer services. For installation information see **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

9. Underdrain Cleanouts.

   a. Underdrain clean-outs, or flushing wyes, shall be located adjacent to every sanitary sewer manhole and shall be rated for HS-20 traffic loadings.

   b. Cleanout risers shall be four (4″) inches in diameter, solvent welded, and shall be designed and constructed to avoid damage from ice or frost.

   c. For compaction purposes, underdrain cleanouts shall be located a minimum of two (2′) feet from the outside diameter of the adjacent manhole.

10. Perforated Underdrain Laterals (Services).

   a. Perforated underdrain laterals (services) shall be encased with washed, crushed, rock protected by a geotextile fabric. The washed stone shall extend beyond the pipe a minimum of twelve (12″) inches, wrapped completely with a geotextile fabric.

b. Where overlaps of the geotextile fabric occur, overlap the downstream sock a minimum twelve (12″) inches. Secure the upstream end of the fabric. Once wrapped, perforated underdrains shall be installed in the same manner as non-perforated underdrains.

c. Underdrain laterals shall connect to the street underdrain a minimum of five (5′) feet upstream or downstream of the sanitary sewer manhole.

d. Extend underdrain laterals at a constant grade from the street underdrain connection to the lot being served. Recommended slope is one eighth (⅛″ / 1′) inch per foot (one (1%) percent slope).

e. The end of the lateral underdrain shall be marked with a two by four (2″ x 4″) inch wood post labeled "UNDERDRAIN". Maintenance of the marker posts shall be the responsibility of the Contractor.

C. Lift Stations.

1. Sewage pumping (lift) stations shall be installed in accordance with the manufacturer's recommendations and at the locations shown on the approved Construction Drawings.

2. Sewage pumping (lift) stations shall be installed in accordance with **Section 1.08.L**, **Lift Stations and Force Mains**, and **Section 1.09.D**, **Lift Stations and Force Mains – Design**, of these Design Specifications.

3. Location.

a. Flooding Damage. Sewage lift stations shall not be subject to damage by a one hundred (100-yr) year flood event. A suitable site, preferably located off the right-of-way of streets and alleys should be provided.

b. Accessibility and Security. Lift stations should be readily accessible to maintenance vehicles under all weather conditions. The facility shall be located off the travelled way. Security fencing and access hatches with locks shall be provided. Security fencing, of a type and height approved by the Town, shall encompass the entire perimeter of the lift station site.

c. Ownership. Lift stations shall be located on property deeded to the Town of Windsor. Property shall be adequately dimensioned to accommodate lift station appurtenances such as wet well, dry well, generator, controls, yard hydrant, etc, and still allow convenient access for repair, maintenance, and overhaul.

d. Spill Containment. Lift stations shall not be located in areas subject to environmental damage or where sewage spills cannot be contained.

4. Appurtenances.

a. All sewage pumping (lift) stations shall be installed, complete in place, with all required and necessary appurtenances.

b. Structures for lift stations shall include completely separated wet and dry wells.

c. All lift stations shall include suitable equipment and access for the removal of pumps, motors and valves. All dry well installations shall have double leaf hinged vault access doors as specified in **Section 02280, Waterline Manholes and Vaults**, **2.5 Hinged Vault Access Doors**, of these Construction Specifications.

d. Suitable and safe means of access shall be provided to all areas of the station, including dry wells and wet wells. Ventilation is required in both types of wells.

e. Housing for pumping equipment and controls shall be readily accessible and weather proof.

f. At least three (3) pumps shall be provided.

g. Electrical equipment meeting the needs of the lift station, including required emergency power equipment.

h. Controls, valves, flow measurement systems, alarms, and ventilation systems shall also be provided as detailed in accordance with **Section 1.08.L**, **Lift Stations and Force Mains**, and **Section 1.09.D**, **Lift Stations and Force Mains – Design**, of these Design Specifications.

5. Lift Station Operation and Maintenance.

a. The Contractor/Owner shall supply the Town's Sewer Department with two (2) complete sets of shop drawings, pump curves, operation and maintenance instructions, including emergency procedures, maintenance procedures, tools and such spare parts as may be considered necessary.

b. Operation and maintenance instructions shall be specific to the equipment installed. All non-relevant reference material shall be removed or clearly crossed out using heavy red line.

c. All emergency power generation equipment should also be provided with operation and maintenance instructions requiring routine starting and running of such units at full load.

D. Force Mains.

1. Sanitary sewage force mains from lift stations shall be in accordance with the Design Engineer's recommendations and at the locations, elevations, and dimensions shown on the approved Construction Drawings.

2. Force mains, being pressurized conduits, shall be installed in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

3. Vaults and blow off valves shall be installed at all "low points" in force mains.

4. Manually operated air relief valves (ARV) shall be installed in force mains at "high points".

5. All force main installations, regardless of pipe material, shall require the installation of a tracer wire. Tracer wire shall be installed with the force main and into a test station every five hundred (500′) feet, in accordance with these Construction Specifications, **Section 02220, Waterline Pipe Installation**.

6. All force main installations, regardless of pipe material, shall require the installation of a plastic warning locator tape indicating "SEWER FORCE MAIN BURIED BELOW" placed eighteen (18″) inches above the top of pipe.

E. Air Relief and Vacuum Relief Valves.

1. Air release (ARV) valves, Air/Vacuum (AVV) valves, and Combination air valves (CAV) shall be installed at the locations shown on the approved Construction Drawings.

2. Where necessary, ARV, AVV, and/or CAV valves shall be installed at each high point in force main lines, where there is an abrupt change of slope, at line valves where the force main line slopes away from the valve, or as required by the Town Engineer.

3. Installation shall include gate valves (same size as the ARV or AVV valve) between saddle and air valve for maintenance purposes.

4. The inlet connection of ARV, AVV, and CAV valves shall be a minimum of two (2″) inches in diameter conforming to AWWA C800.

5. All ARV, AVV, and CAV valves shall be installed in pre-cast concrete manholes or vaults fitted with air vents open to the atmosphere. See these Construction Specifications, **Section 02280, Waterline Manholes and Vaults**, for additional specifications.

6. All ARV, AVV, and CAV valves shall be approved by the Town Engineer prior to installation. See **Section 1.05.A.3.** of these Design Specifications for additional information.

3.4 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J. and as modified herein:

A. Pipe Tests. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for pipe testing requirements and specifications.

B. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

C. Grease Traps and Interceptors. Prior to Initial Acceptance, and pursuant to the Inspector's direction, the Design Engineer is required to certify the appropriate treatment device, grease trap and/or interceptor, was installed in accordance with final manufacturer's recommendations. A certification form is required and available from the Town's Building Department.

D. Lift Station Startup.

1. The Contractor/Owner shall demonstrate the flawless operation of the lift station in manual and automatic mode prior to acceptance by the Town.

2. The startup operations shall demonstrate that the lift station and all components are completely functional including all valves, vents, controls, telemetering devices, and alarms.

3. A factory representative for the pumps and controls and generators shall be on site for the startup operation.

E. After approved factory assembly, each valve shall be given operation and hydrostatic tests.

F. Tracer Wire Testing.

1. Test tracing wire system by passing electric current through the wire and demonstrate that the tracing wire is capable of locating the force main.

2. If the wire will not pass current testing, locate the break in the circuit and repair and test until tracer wire works in accordance with its intended use.

G. Operational Inspection. At the completion of the project, prior to Initial Acceptance, and in the presence of a Town representative, the Contractor shall operate all valves and lift stations, pumps, and accessories to ascertain that the entire facility is in good working order, all lift stations and force mains are functioning, and all grease traps and sand/oil interceptors are plumb and square, plumbed properly, and operational.

END OF SECTION

SECTION 02440

SANITARY SEWER SERVICE LINES

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for sanitary sewer service lines including wyes, risers, services lines, plugs, markers, and related appurtenances, used in sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of sewer services and appurtenances in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All sewer service lines and appurtenant materials shall be furnished complete with all wyes, fittings, risers, specials, backfill, compaction, groundwater barriers, testing, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All sewer service lines, tapping saddles, risers, clean-outs and plugs and markers are subject to approval by the Town of Windsor Engineering Department and/or Sewer Department.

B. Construction Staking. Location staking for horizontal control shall be provided for all sewer line services, per **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All sewer service lines, tapping saddles, risers, and clean-out assemblies shall be new and shall be handled, stored and protected in a manner that will prevent damage to materials, coatings, and finishes.

B. All material shall be kept free from dirt, oil, and grease and any other source of contamination.

1.5 INSTALLATION OF SERVICE TAPS

A. No taps shall be made on any Town of Windsor sewer line without prior permission from the Town.

B. Service taps on live, existing mains shall be made only under the direct supervision of the Town. The Contractor shall coordinate with the Town Sewer Department and/or Engineering Department.

C. The Town reserves the right to make taps in lieu of the Contractor and the right to deny permission for any main to be tapped.

D. Do not install sanitary sewer service lines when the trench contains water or when the trench bottom is unstable as determined by the Town Engineer. Water that is encountered in the trench shall be removed

to the extent necessary to provide a firm subgrade, permit connection to be made in dry conditions, and to prevent entrance of water into the service line. The pipe shall not be used to dewater the trench.

PART 2 – MATERIALS

2.1 SERVICE LINE PIPE

A. All sanitary sewer service lines, risers, and other appurtenances, shall be Polyvinyl Chloride (PVC) SDR 35, colored green, sewer pipe, unless approved otherwise by the Town Engineer or Town's Sewer Department.

B. See these Construction Specifications, **Section 02422 Polyvinyl Chloride (PVC) Non-Pressure Pipe**, for requirements and specifications.

2.2 WYES, TAPS AND SADDLES

A. Sanitary sewer wyes and service connections are typically four (4″) inch or six (6″) inch diameter.

B. Wyes, risers, and service connections shall be of the same material and specification as the sanitary sewer main being installed.

C. Where sewer service wyes have not or could not have been installed in an existing sanitary sewer collection main, the sewer tap shall be made using a tapping saddle or approved fitting.

D. Acceptable tapping saddle manufacturers are:

1. "ROMAC"
2. "Insert-a-Tee"
3. Or approved equal.

2.3 FLEXIBLE COUPLINGS

A. When bell and spigot pipe joints cannot be made, a flexible coupling may be permitted.

B. Acceptable flexible coupling manufacturers are:

1. Dallas Specialty & Manufacturing Co. – Flexible Couplings.
2. Indiana seal – Flexible Couplings.
3. Fernco – Flexible Couplings.
4. Joints Inc. – Flexible Couplings.
5. Mission Rubber Co. – Flexible Couplings.
6. Or approved equal.

2.4 GROUNDWATER BARRIERS

A. When high groundwater conditions exist or as directed by the Town Engineer, groundwater barriers shall be installed on sanitary sewer service lines.

B. Groundwater barriers shall meet the requirements set forth in **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

PART 3 – EXECUTION

3.1 GENERAL

A. Only licensed and bonded Contractors will be permitted to install sewer service connections in the Town of Windsor.

B. The Contractor shall install all service wyes on new sewer line installations, using approved PVC, SDR 35 prefabricated wyes with approved equipment, and install the sewer service lateral line to a point five (5′) feet beyond the property line prior to any testing of the sewer main.

C. Sanitary sewer service connections shall be installed at locations designated on the approved Construction Drawings.

D. The Contractor shall install the sanitary sewer service lateral to the horizontal location and to the final grade as determined by grade stakes set in the field.

1. Grade stakes shall be placed a minimum of five (5′) feet from the location of the end of the lateral.

2. Grade stakes shall not be disturbed prior to inspection of the service by the Town.

E. The Contractor shall mark the location of all sewer services in the following manner:

1. Immediately at the end of the service lateral place a wood two by four (2″ x 4″) post, four (4′) foot out of the ground, extending to the service flowline, with top two (2′) feet painted green.

2. Place an imprinted "S", three (3″) inches high, into the face of the curb and gutter. See **Town of Windsor, Design Criteria and Construction Specifications, Division I, Streets, Section 03310, Curbs and Gutters**, Subsection 3.10.B.

F. Contractor shall inspect all wyes, tapping saddles, risers, service lines, couplings, bends, and other appurtenances for cracks, dents, abrasions, damaged linings or coatings, or other flaws and ensure that they are free of dirt, grease, or other foreign objects prior to installation.

G. All sanitary sewer service lines shall be installed with a constant slope from the main to the property line.

3.2 PLANNING AND PREPARATION

A. In anticipation of sewer service line installation, excavating for the trench, trench bottom stabilization, and proper pipe bedding and backfill and compaction shall conform to the requirements as detailed in these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**.

B. Existing Utilities.

1. The horizontal and vertical location of existing utilities shall be field verified prior to start of sewer service line construction.

2. Any deviation in construction from what is shown on the approved Construction Drawings shall be reported to the Design Engineer and the Town Engineer immediately and documented on the "As-Constructed", Project Record Drawings.

C. Installation of sewer service lines and appurtenances shall, generally, be in conformance with that process specified in these Construction Specifications, **Section 02420, Sewer Line Pipe Installation**. The joining of service pipes, wyes, risers, and other appurtenances shall be handled in a similar manner as sewer line pipe installation.

D. Field measurements of the actual location of service lines and appurtenances shall be made prior to backfilling for recording on the "As-Built" Project Record Drawings.

3.3 SERVICE LINE TAPS

A. The Contractor shall not make taps on Town sewer lines without permission from the Town Engineer and/or the Sewer Department.

B. The Town of Windsor reserves the right to deny permission for any sewer line to be tapped.

C. Taps shall not be made within two (2′) feet of any joint or fitting or within five (5′) feet of a manhole.

D. Taps shall be separated by at least two (2′) feet, measured along the pipe length, even when taps are made on opposite sides of the pipe.

E. No more than four (4) service taps shall be permitted on any one (1) joint of pipe.

F. The spring line of the service connection shall be as shown on the Standard Detail Drawings of the Town of Windsor, and no closer than three (3′) feet to the bell or spigot of the pipe.

3.4 SERVICE LINES

A. Sanitary sewer service lines shall not be installed in trenches with other potable conduits/utilities. Water service lines shall be separated from sanitary sewer services a minimum of ten (10′) feet horizontally and eighteen (18″) inches vertically.

B. Sanitary sewer service connection wyes shall be placed along with the main line at the locations shown on the approved Construction Drawings. Wyes shall be angled upwards so that the upper invert of the one eighth (⅛) bend connected to the fitting will have an elevation equal to or higher than the inside crown of the sanitary sewer main.

C. Riser connections shall be installed where the elevation of the top of the branch is more than twelve (12′) feet below finished ground. Riser connections shall ordinarily reach to a grade ten (10′) feet below finished ground surface. Field measurements of the actual location of service connection wye branches and length and location of risers shall be made prior to backfilling for recording on the “As-Constructed” Project Record Drawings.

D. All sanitary sewer service lines shall be constructed at a constant grade from the wye, or tap, or top of riser on the collection main, to the end of service and, eventually, to the building.

E. All sanitary sewer service lines shall be installed with a slope that meets the following criteria:

1. Maximum grade of all sanitary sewer services shall be eight (8%) percent.

2. Minimum slope for four (4″) inch services shall be one quarter (¼ in/ft) inch per foot, a two (2%) percent slope.

3. Minimum slope for six (6″) inch services shall be one eighth (⅛ in/ft) inch per foot, a one (1%) percent slope.

F. That portion of the service line between the main sewerline and the building, when installed, shall be uniform in size.

G. When high groundwater conditions exist or as directed by the Town Engineer, groundwater barriers shall be installed on sanitary sewer service lines at the property line. See **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications for groundwater barrier requirements and specifications.

H. Sanitary sewer service lines shall be subject to compaction requirements. See **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications for compaction testing requirements and specifications.

I. When backfilling the service line trench, squeegee sand shall be used a minimum of six (6″) inches above and below the service line at any given location.

J. The end of all sanitary sewer service laterals shall be plugged with an air-tight cap.

K. The end of all sanitary sewer service laterals shall be marked with a two by four (2″ x 4″) wood post.

1. All wooden posts shall extend from the end of the service to a point four (4′) feet, minimum, above the ground surface and the top half shall be painted green.

2. Maintenance of the marker posts shall be the responsibility of the contractor until the sanitary sewer system has been accepted by the Town. After the system has been accepted by the Town, the Owner shall be responsible for maintaining the marker posts until the service line is completed to a structure.

3.5 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J. and as modified herein:

A. Pipe Tests. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for pipe testing requirements and specifications.

B. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

C. The Contractor shall ensure that the wye, riser, service line, and air-tight plug remain exposed until after inspection and the approval for backfill is given by the Town.

END OF SECTION

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SECTION 02450

SANITARY SEWER MANHOLES

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for sanitary sewer manholes including bases, risers, and cone sections, grade rings, steps, ring and covers, markers, and related appurtenances, used in sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in their installation, in conformance with these specifications and in accordance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or, with prior approval, as established in the field.

All sanitary sewer manholes and appurtenant materials shall be furnished complete with all base, risers, and cone section, gaskets, steps, grade rings, seals, ring and cover, specials, backfill, compaction, groundwater barriers, testing, markers, and other accessories.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All sanitary sewer manholes and appurtenances are subject to approval by the Town of Windsor Engineering Department and/or Sewer Department.

B. Construction Staking. Location staking for horizontal and vertical control shall be provided for all manhole installations, per **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D., and as modified herein:

A. All sanitary sewer manholes and appurtenances shall be new and shall be handled, stored, and protected in a manner that will prevent damage to materials, coatings, and finishes.

B. All material shall be kept free from dirt, oil, and grease and any other source of contaminations, including at the time of installation.

PART 2 – MATERIALS

2.1 PRE-CAST CONCRETE MANHOLES

A. Pre-cast concrete manhole bases, barrels, and cone sections shall be manufactured in accordance with ASTM C478, and shall be made with Type V cement conforming to ASTM C150, and shall be in accordance with **Section 03340, Pre-Cast Concrete**, of these Construction Specifications

1. All cone sections shall be the eccentric type unless approved otherwise by the Town Engineer or Town's Sewer Department.

2. Shallow, flat slab tops may be used where called for specifically on the approved Construction Drawings. Where required, a slab design shall be prepared by the Design Engineer, subject to review and approval by the Town Engineer.

B. Reinforcing materials shall conform to ASTM A185, ASTM A615, ASTM A996, and ASTM C478.

1. Reinforcing steel bars shall be Grade 60.

2. Minimum reinforcement for bases of manholes shall consist of welded wire fabric, 4x4 – "W4xW4," reference ASTM C478 and ASTM A185.

2.2 CAST-IN-PLACE MANHOLE BASES

A. Cast-in-Place concrete manhole bases shall only be allowed for the connection to existing sanitary sewer systems, on a case by case basis, and where otherwise approved by the Town Engineer.

B. Cement used in cast-in-place concrete manhole bases shall conform to ASTM C150, Type V. Fly ash, if approved, shall be Class F, conforming to ASTM C618, and shall not exceed twenty (20%) percent.

C. All fine and course aggregate materials shall conform to ASTM C33.

1. Fine aggregate shall be clean, sharp, natural sand.

2. Coarse aggregate shall be clean, strong crushed gravel or stone. Gradation shall be as specified under concrete mixes.

D. Concrete reinforcing materials shall meet the following requirements:

1. Deformed reinforcing steel bars shall be Grade 60, and shall conform to ASTM A615 or ASTM A996.

2. Minimum reinforcement for bases of manholes shall consist of a mat of number four (#4) rebar at twelve (12″) inches on center each way, reference ASTM A185.

3. Fiber mesh reinforcement: one and one half (1½ lbs/cy) pounds per cubic yard of fiber mesh or approved equivalent.

E. Concrete Mix design shall meet the following requirements:

1. Concrete used in cast-in-place concrete manhole bases shall have a minimum of six (6) sacks per cubic yard, and shall develop a minimum compressive strength of thirty five hundred (3500 psi) pounds per square inch after twenty eight (28) days.

2. Concrete shall have a maximum allowable water/cement ratio of fifty hundredths (0.50), by weight.

3. The slump of concrete delivered to the site shall not exceed four (4″) inches.

4. Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C94.

F. For additional information, reference **Section 03310, Cast-in-Place Concrete**, of these Construction Specifications.

2.3 GRADE ADJUSTMENT RINGS

A. Each manhole shall have a minimum of two (2), two (2″) inch thick, grade adjustment rings.

B. Each manhole shall have a maximum of three (3) adjustment rings, not exceeding ten (10″) inches.

C. Maximum height of any grade adjustment ring shall be four (4″) inches.

D. Grade adjustment rings shall have an internal diameter of twenty four (24″) inches.

E. Pre-cast concrete grade adjustment rings shall be manufactured in accordance with ASTM C478, and shall be made with Type V cement.

2.4 MORTAR

A. Mortar shall be Sand-Cement grout.

B. Mortar shall use the following ratio of ingredients:

1. One (1) part Portland Cement conforming to ASTM C150, Type V.

2. Two (2) parts sand conforming to ASTM C144.

3. One half (½) part hydrated lime conforming to ASTM C207, Type S.

2.5 GROUT

A. Grout shall be one of the following types:

1. Pre-mixed, non-shrink, non-metallic grout. Acceptable manufacturers are:

a. QUIKRETE® - Hydraulic Water – Stop Cement #1126.

b. DAYTON Superior – Re-Crete 20 Minute Set.

c. Or approved equal.

2. Job-mixed grout, using the following ratio of ingredients:

a. One (1) part Portland Cement; conforming to ASTM C150, Type V.

b. One (1) part sand; conforming to ASTM C144.

c. One (1) part shrinkage correcting aggregate.

2.6 RING AND COVER

A. All rings shall be maximum eight (8″) inch height.

B. Standard iron ring and covers shall be HS-20 load capable, gray iron conforming to ASTM A48, Class 305B, with a black bituminous finish.

1. The word “SEWER” shall be cast in the cover.

2. Horizontal bearing surfaces of all rings and covers shall be machined to eliminate any rocking action or non-uniform bearing, to fit the ring to exclude water, and to be level with the top of the ring.

3. Pick-hole shall be one and one half (1½″) inch wide by one half (½″) inch deep.

4. Acceptable manufacturers of rings and covers are:

a. Castings, Inc. – MH-250-24CI.

b. Castings, Inc. – MH-400-24CI.

c. Or approved equal.

C. Covers shall be non-perforated checkered pattern with maximum three sixteenths (3/16″) inch raised pattern in non-pedestrian traffic areas and non-perforated, non-skid pattern complying with American with Disabilities Act (ADA) requirements in pedestrian traffic areas. Acceptable ADA covers are manufactured by Castings, Inc. – MH-310-24CI; or approved equal.

D. Manhole ring and covers located within designated one hundred (100-yr) year floodplains and areas subject to frequent water inundation shall be the non-perforated, water-tight, lock down, gasket type cover.

1. Ring and covers shall be HS-20 load capable, gray iron, conforming to ASTM A48, Class 30, with a black coat finish.

2. The word "SEWER" shall be cast in the cover.

3. Horizontal bearing surfaces of all rings and covers shall be machined to eliminate any rocking action or non-uniform bearing, to fit the ring to exclude water, and to be level with the top of the ring.

4. Acceptable manufacturers are:

a. Pamrex.

b. Rexus.

c. Or approved equal.

2.7 MANHOLE STEPS

A. Steps in sanitary sewer manholes shall be corrosion resistant and shall be cast into the manhole wall at the time the concrete manhole section is cast.

B. All steps in manholes shall be made of a minimum of three eights (⅜″) inch diameter grade sixty (60) steel reinforcing rod completely encapsulated in a copolymer polypropylene plastic, conforming to ASTM A615, ASTM C478, ASTM C497, and ASTM D4101.

C. All steps shall be spaced twelve (12″) inches apart, on center, and in uniform alignment.

D. Steps in sanitary sewer manholes shall be no more than twenty four (24″) inches or less than eighteen (18″) inches from the top of the manhole ring or from the bench of the manhole.

E. Manhole steps shall be positioned over the channel bench.

2.8 PREFORMED PLASTIC GASKETS

A. All preformed plastic gaskets shall conform to AASHTO M198 and Federal Specifications SS-S-00210(210A); Type I, rope form.

B. The diameter of the preformed plastic gasket shall be one and one half (1½″) inches.

C. Gaskets must be pliable at the time of installation at a temperature of ten (10° F) degrees Fahrenheit and above, without being heated.

D. Primer is required on all joints. Primer shall be supplied by the gasket manufacturer.

E. All manhole sections shall have two (2) preformed plastic gaskets per section joint.

F. Approved manufacturers of preformed plastic gaskets are:

1. Hamilton-Kent Manufacturing Co. – Kent Seal.

2. Con Seal – CS – 202.

3. “RAMNECK” -

4. Or approved equal.

2.9 PIPE PENETRATION GASKETS

A. All sanitary sewer pre-cast concrete manholes shall come with pipe penetration gaskets pre-set in the manhole base by the manufacturer at the correct elevation and location as shown on the approved Construction Drawings.

B. Approved manufacturers of pipe penetration gaskets are:

1. A-LOK Products, Inc. – “A-LOK”.

2. PRESS-SEAL Gasket Corporation – “PSX”.

3. Or approved equal.

2.10 LINING

A. In areas subject to high corrosive activity, the Town Engineer or the Town’s Sewer Department may require manholes to be coated with a special lining.

B. Lining shall be applied at a minimum of sixty (60) mils and in accordance with manufacturer’s recommendations.

C. Approved manufacturers of manhole lining coating shall be as determined by the Town Engineer or the Town’s Sewer Department.

2.11 REFERENCE MARKERS

A. Whenever a manhole is located in cultivated areas, a reference marker shall be installed. The reference marker shall be a six (6″) inch galvanized pipe, bollard post, filled with concrete. The pipe shall be nine (9′) feet long, set in a minimum twelve (12″) inch diameter hole to a depth of four (4′) feet and filled with concrete.

B. The pipe shall be painted green. The pipe shall have reflectors as required by the Engineer. Location direction shall be stamped onto the concrete on top of the post and distance to the centerline of the manhole cover shall be painted on the post in red.

PART 3 - EXECUTION

3.1 INSPECTION

A. Pre-cast concrete manholes, gaskets, ring and cover, steps, linings, and pre-cast concrete grade adjustment rings shall be examined for cracks, abrasions, or other flaws prior to installation.

B. Damaged or flawed materials shall be rejected and removed from the site.

3.2 PREPARATION

Reference **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

3.3 MANHOLE INSTALLATION

A. Sanitary sewer manholes shall be constructed at the location and to the elevation indicated on the approved Construction Drawings, or to accommodate field conditions, with the prior approval of the Town.

B. Height. When the overall height above the base of a manhole to the ring and cover is less than eight (8′) feet, a flat slab, HS-20 top shall be required.

1. Access holes for flat slab top manhole installations shall be offset from center and placed over the steps.

2. If the overall height above the base of a manhole to the ring and cover is less than three and one half (3½′) feet, the access hole shall be centered.

C. Barrel Diameter. The minimum internal diameter of the manhole barrel shall be forty eight (48″) inch diameter for sanitary sewers of twelve (12″) inches or less, sixty (60″) inch diameter for sewers fifteen to twenty seven (15″ - 27″) inches, and seventy two (72″) inch diameter for sewers thirty (30″) inches and larger.

1. Manholes shall be so constructed as to form a circle in a horizontal plane.

2. The internal diameter shall be maintained to a point between fifty four (54″) inches to forty eight (48″) inches from finished grade. From that point, the manhole shall be eccentrically tapered to the internal diameter of twenty four (24″) inches. The point at which the internal diameter is twenty four (24″) inches shall be not more than eighteen (18″) inches or less than twelve (12″) inches below the finished grade of the manhole cover.

D. Drop Manholes.

1. Where the invert elevation difference between the invert in and invert out is less than twenty four (24″) inches, the channel invert through the manhole shall be formed to make a smooth transition between the incoming and outgoing inverts.

2. Where the invert elevation difference between the invert in and invert out is twenty four (24″) inches or more, an exterior drop apparatus shall be provided. Drop manholes are discouraged and shall be allowed on a case by case basis only.

3. Encase the entire outside drop connection in formed concrete prior to backfilling due to the unequal earth pressure that would result from backfilling near the manhole.

4. See Town of Windsor Standard Construction Details for exterior drop manhole installation specifics.

E. Cast-in-Place Concrete Bases.

1. Manholes for sanitary sewer installation shall be pre-cast concrete; cast-in-place concrete manholes shall only be allowed upon approval of the Town Engineer or the Town's Sewer Department. All constructed manholes shall be sealed tightly to prevent storm or other non-sewage flows from entering the sanitary sewer system.

2. Invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sanitary sewer pipe section, of uniform slope, formed to ensure smooth laminar flow through the manhole.

3. Form inverts directly in the concrete of the base, or for a straight through manhole with no other inlets, the channel may be constructed by laying a full pipe section through the manhole and cutting out the top half of the pipe after the surrounding concrete has hardened.

4. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as the manhole will permit.

5. Pipe size changes in the manhole shall be accomplished by matching the pipe crowns and gradually and evenly forming the channel directly in the concrete to accommodate the pipe size differential.

6. The floor of the manhole outside of the channels (the bench) shall have a smooth trowel finish and shall slope toward the channels at one (1 in/ft) inch per foot.

7. Where shown on the approved Construction Drawings, for future stub-out, a ten (10′) foot length of pipe of the proper size shall be extended out of the manhole upstream where future laterals may be connected. The stub-out shall be sealed with a water-tight plug at its outer end and an invert shall be built into the manhole for such lateral connections.

8. Cast-in-place manhole bases shall be thoroughly bonded to the barrel of the pipe.

   a. Install an approved rubber gasket on the pipe barrel.

   b. All connections with the pipe shall be made without projections or voids.

   c. Inverts must meet the requirements of these specifications.

9. Cast-in-place manhole bases shall not be less than eight (8″) inches nor more than twelve (12″) inches under the invert of the channel and have a mat of number four (#4) rebar at twelve (12″) inches on center each way.

10. The diameter of cast-in-place manhole bases shall be six (6′) foot for four (4′) foot barrels, seven (7′) foot for five (5′) foot barrels and eight (8′) foot for six (6′) foot barrels.

11. Concrete for cast-in-place manhole bases shall be placed on properly prepared sub-base. The ground surface below the bottom of the base shall be over-excavated at least six (6″) inches and backfilled with compacted, approved, granular material. The compacted, prepared gravel base shall be carefully leveled to give uniform support to the base over the entire area. Reference **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

F. Pre-Cast Concrete Bases.

1. Pre-cast concrete manhole bases shall be installed in a similar manner as described for cast-in-place concrete manhole bases referenced above.

2. Pre-cast concrete manhole bases shall be manufactured with pipe penetration gaskets pre-set in the manhole base by the manufacturer at the correct elevation and location as shown on the approved Construction Drawings.

G. The manhole base shall be set plumb and at the proper location to center the manhole correctly.

H. Manhole sections shall be joined to each other using preformed flexible plastic gaskets on both interior and exterior shiplaps. Align manhole sections so that steps are in uniform alignment. The manhole section shall be joined to the base using a double row of preformed flexible plastic gaskets.

1. All joint surfaces shall be kept clean and dry during installation.

2. Gaskets shall be pliable at the time of installation.

3. Primer shall be used on both section/base surfaces unless directed otherwise by the Town Engineer.

4. Overlap the gasket material six (6″) inches.

5. Leave protective paper on the outside of gaskets during application and remove when the joint is ready to be joined.

6. The manhole barrels shall be water-tight at all joints and riser sections.

I. Concrete grade adjustment rings, minimum of two (2) required, shall be used to bring the ring and cover to grade.

1. The total height from the top of the cone section to the finished grade shall not exceed eighteen (18″) inches.

2. A minimum of two (2), two (2″) inch thick, grade adjustment rings are required, maximum of three rings, not exceeding ten (10″) inches in total height.

3. The adjustment rings shall be flush with the inside of the manhole and grouted.

J. Adjustment rings, and cover rings shall be joined to the manhole section and to each other using flexible plastic gaskets or sealing compound such as “RAMNEK”, or approved equal.

1. All joint surfaces shall be kept clean, dry, and warm during installation.

2. Manhole section shall be grouted to adjustment rings and cover rings on the inside.

K. All penetrating holes, and other imperfections shall be filled with non-shrink grout, to provide a smooth finished appearance.

L. If the manhole is subject to conditions that produce high levels of hydrogen sulfide (H_2S), the interior surfaces of manholes shall have an approved epoxy coating, or a PVC lining, or another approved method as determined by the Town Engineer.

M. If groundwater is observed to be above the top of the sewer pipe, the exterior surfaces of manholes shall have a coating of coal tar to the top of the manhole, and all joints shall be applied with external joint wrap.

N. When manholes are located in open fields and cultivated areas, where practical, they shall be left between ten to twelve (10″ - 12″) inches above grade, properly marked with a bollard post reference marker painted green. A locking ring and cover shall be required and the manhole shall be surrounded with a four by four (4′ x 4′) foot concrete pad six (6″) inches thick.

O. The bollard post shall be a six (6″) inch, galvanized, post filled with concrete and painted green. Location direction shall be stamped onto the concrete on top of the post and distance to the centerline of the manhole cover shall be painted on the post in red.

3.4 CONNECTIONS TO EXISTING MANHOLES

A. Sanitary sewer pipe connections to existing manholes where there are no existing pipes stubbed out, shall be constructed in such a manner that the finished work will conform to the requirements specified for new manholes.

B. Connections shall be made by core-drilling and breaking out as small an opening in the existing manhole as necessary to insert the new water-stop gasket and sewer pipe. Chipping or breaking out manhole walls are not allowed. Use of a rotary hammer is not acceptable.

C. Grind the existing manhole base to the cross-section of the new pipe and finish with grout to form a smooth continuous invert similar to what would be formed in a new concrete base. Chipping or breaking out the manhole base is not acceptable.

D. Seal the annular space between the pipe and existing manhole wall with a "modular sealing unit" and smooth finish inside the manhole wall with non-shrink grout. "Modular sealing units" shall be "A-LOK", or approved equal.

3.5 UNDERDRAINS BENEATH MANHOLES

A. Sanitary sewer manholes installed over underdrains shall have all manhole bases placed on stabilization material per **Section 02210, Trenching, Backfill and Compaction**, of these Construction Specifications.

B. Reference **Section 02430, Sanitary Sewer Appurtenances**, of these Construction Specifications for underdrain installations.

3.6 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.J. and as modified herein:

A. Manhole Tests. Reference these Construction Specifications, **Section 02460, Sanitary Sewer Testing**, for sanitary sewer manhole testing requirements and specifications.

B. Soil Compaction Testing. Reference these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction** for compaction testing requirements and specifications.

C. Concrete Testing. Reference these Construction Specifications, **Section 03310, Cast-in-Place Concrete**, and **Section 03340, Pre-Cast Concrete**, for concrete testing requirements and specifications

D. The Contractor shall ensure that all manhole installations remain exposed until after inspection and the approval for backfill is given by the Town.

E. The location of all sanitary sewer manholes shall be referenced by the Contractor or Design Engineer to a minimum of two (2) permanent surface references, and recorded on the "As-Constructed" Project Record Drawings.

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SECTION 02460

SANITARY SEWER TESTING

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes specification procedures for sanitary sewer cleaning and testing, including lamping, air-test, infiltration test, video test, smoke test, deflection test, vacuum test for manholes, and related paraphernalia used in sanitary sewer testing procedures within the Town of Windsor and includes the acceptable materials and practices which may be used in the testing of these sewer appurtenances, in conformance with these specifications and in accordance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or as established in the field.

All sanitary sewer testing services, reports, and appurtenant materials shall be furnished complete with all video equipment, gauges, cameras, measuring devices, and recording apparatus, and other accessories, necessary to complete the required tests.

1.2 SCOPE

A. This section addresses the testing of sanitary sewer collection mains, laterals, manholes, and appurtenances.

B. All sanitary sewer pipelines shall be lamp tested per these specifications.

C. All sanitary sewer pipelines shall be air tested per these specifications

D. All sanitary sewer manholes shall be vacuum tested per these specifications.

E. All sanitary sewer collection systems shall be video inspected per these specifications.

F. Additional testing and/or retesting shall be at the discretion of the Town Engineer.

1.3 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein with these Standards (as applicable):

A. ASTM C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum), latest revision.

B. ASTM F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision.

1.4 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. Contractor shall furnish all labor, materials, tools, and equipment to clean the pipe and appurtenances, conduct the test, and perform all work incidental thereto.

B. Low pressure air test along with video inspection shall be required on the entire length of all pipeline installations. The use of alternate testing methods may be allowed or required in addition to those stated above. Alternate testing methods include infiltration test, smoke test, and deflection tests.

C. All test results shall be submitted to the Town within ten (10) working days from the day of testing. There shall be no pipe in place for more than ninety (90) days prior to the completion of testing.

D. Precautions should be taken to prevent joint drawing during the test. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced immediately.

PART 2 – MATERIALS

2.1 SECTION NOT USED.

PART 3 - EXECUTION

3.1 GENERAL

A. All sanitary sewer pipe and appurtenances shall be cleaned and tested after backfill operations have been completed and acceptable compaction test results have been submitted to the Town, but before paving and curb and gutter improvements are installed.

B. All of the pipeline and manholes shall be cleaned and be free of sand, dirt and debris. The pipeline must be cleaned by the use of a high pressure jet. Care shall be taken to ensure that no non-sewage water enters the existing sanitary system. Should the Contractor cleaning the line allow water to enter the existing system, damages to the system, costs of treating the water, and fines in accordance with applicable codes shall be at the Contractors expense.

C. The Contractor shall furnish all equipment, labor, and incidentals necessary to perform tests. The pressure gauge shall be capable of indicating pressure to the nearest one tenth (0.1 psi) pounds per square inch increment.

D. The Town may witness tests and the inspector shall record times, leakage readings, and pressure over the test period. Contractor shall provide the Town a minimum forty eight (48 hrs) hours advance notice of any tests.

3.2 ALIGNMENT TEST

A. Lamp each section of sanitary sewer between manholes to determine whether any displacement of pipe has occurred.

B. Perform lamping after pipe trench is compacted and brought to grade or pavement subgrade.

C. “Full moon” shall be visible for vertical grade alignment. No less than “half moon” shall be visible for horizontal alignment.

D. Repair poor alignment, displaced pipe, or other defects discovered and verify corrective action with another lamping.

3.3 AIR TESTING SANITARY SEWER MAINS

A. Conduct tests in conformance with ASTM F1417 and these specifications.

B. All pressures specified in this section assume pounds per square inch gauge (psig) greater than the average backpressure of any groundwater above the pipe, not greater than nine (9) psig. When groundwater is present, increase test air pressures to compensate for the back pressure. Each foot of groundwater produces approximately forty three hundredths (0.43 psi) pounds per square inch back

pressure. For groundwater in excess of five (5′) feet (2.15 psig) above the crown of the pipe, an infiltration test shall be used in addition to air testing.

C. Preparation for Tests.

1. Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results. Pipe may be tested without pre-wetting if the pipe line to be tested is submerged in groundwater.

2. Provide a relief valve on the pressuring equipment to avoid over pressurizing and damaging an otherwise acceptable line. Set relief valve at five (5) psig greater than the average back pressure.

3. Plug and brace all openings in the main sanitary sewer line and the upper connections. Check all pipe plugs with a soap solution to detect any air leakage. If leaks are found, release the air pressure, eliminate the leaks and start the test procedures over again.

D. Test Procedure.

1. Add air slowly to the portion of the pipe being tested until the internal pressure of the sewer line is raised to approximately four (4) psig greater than the average back pressure. Maintain the air pressure between three and a half (3½) psig and four and a half (4½) psig until the air temperature in pipe is stabilized with the pipe/ground temperature.

2. After two (2 min) minutes, disconnect the air supply and let the initial pressure allowed, drop to three and a half (3½) psig in excess of the groundwater back pressure.

3. Determine the time required for the air pressure to drop from three and a half (3½) psig to three (3) psig. For this one half (½) psig drop in air pressure, the time elapsed shall not be less than:

$$\mathbf{T = 0.0237\ (L)\ (D^2)}$$

Where: T = shortest time(s) allowed for air pressure to drop one (1) psig (seconds).
L = length of pipe test section (feet).
D = diameter of pipe (inches).

4. The pressure drop must meet or exceed the minimum allowable time limits for the time (min:sec) given in the following table:

Table 02460-1
Allowable (½) psig Pressure Drop Times (min:sec)

Pipe Diameter (in)	Pipe Length (feet)						
	0-150	200	250	300	350	400	500
8	7:34	7:34	7:34	7:36	8:52	10:08	12:38
10	9:26	9:26	9:53	11:52	13:51	15:49	19:45
12	11:20	11:24	14:15	17:05	19:56	22:47	28:26
15	14:10	17:48	22:15	26:42	31:09	35:36	44:26
18	19:12	25:36	32:00	38:24	44:48	51:12	63:59

5. If lateral or service lines are included in the test, their length may be ignored for computing required test time if the test time requirements are met. If the test section fails, time shall be recomputed to include all the lateral length using the same formula with the length being the total service line lengths and the diameter of lateral pipe.

6. The one half (½) psig drop in air pressure requirement used above to compute the times, is for PVC pipe. Only with Town approval, other types of pipe may utilize different air pressure drop values.

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7. If the recomputed test time is short enough to allow the section tested to pass, then the test section meets the requirements of this specification.

E. Test Failure. Sections of the pipe which fail the air test shall have the defects repaired and the test repeated.

F. The Contractor shall follow all precautions necessary to perform a safe and successful test. Plugs used to isolate the line for the air test must be securely braced to avoid the unintentional release of the plug. Gauges, air piping manifolds, and control valves shall be located above ground. No one shall be permitted to enter a manhole when a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure relief device designed to relieve the pressure when in excess of five (5) psig greater than the average back pressure.

3.4 VACUUM TESTING MANHOLES

A. Manholes shall be tested before the ring and cover and grade adjustments rings are installed, and after backfill and compaction is complete.

B. Conduct tests in conformance with ASTM C1244 and these specifications.

C. Preparation for Tests.

1. All penetrating holes and other imperfections shall be filled with an approved non-shrink grout, to provide a smooth finish appearance.

2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manholes.

3. Service laterals entering manhole shall be tested with the manhole.

D. Test Procedure.

1. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendation.

2. A vacuum of ten (10″) inches mercury shall be drawn in the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum pump to drop to nine (9″) inches mercury.

3. The vacuum drop must meet or exceed the minimum allowable time limits for the times (sec) given in the following table:

Table 02460-2
Manhole Vacuum Testing Durations (sec) [for 1" mercury]

Depth (ft)	Diameter (in)			
	48	54	60	72
8	20	23	26	33
10	25	29	33	41
12	30	35	39	49
14	35	41	46	57
16	40	46	52	67
18	45	52	59	73
20	50	53	65	81
22	55	64	72	89
24	59	64	78	97

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E. If the manhole fails any test, the defects shall be located and the necessary repairs shall be made by an approved method and the manhole shall be retested until a satisfactory test is obtained.

3.5 INFILTRATION TESTING SANITARY SEWER MAINS

A. If groundwater exists in excess of five feet (5′) feet above the pipe crown, an infiltration test for leakage shall be used in addition to the air pressure test.

B. The Contractor shall provide a pre-approved device capable of measuring flow in the pipe in fifteen (15 min) minute intervals and providing a total flow at the end of the testing period.

C. Flow measurement shall be twenty four (24 hrs) hours minimum and shall be conducted only after backfill and trench/area dewatering operations are complete and groundwater has returned to normal elevations.

D. The maximum allowable infiltration for sanitary sewers shall not exceed fifty (50 gpd/in/mi) gallons per day per inch nominal diameter pipe per mile.

3.6 TELEVISING SANITARY SEWER MAINS

A. All sanitary sewer lines shall be televised and a video submitted to the Town for approval prior to the placement of any asphalt or concrete surfaces.

B. The televising shall be made by the Contractor.

1. The recording shall be made using a color camera, self-propelled, having sufficient light to show details of problem areas and joints.

2. The camera shall have a swivel head capable of looking up each service connection.

3. Camera speed shall not exceed three (3 fps) feet per second.

4. Sewer mains shall be flushed and clean of debris prior to televising.

5. Televising shall be performed while the main is draining water from the flushing operation, or during the supply of water to identify sags or flat areas.

6. If problem areas or concerns are seen by the operator, then the camera shall be backed up and an extended look at the area will be recorded.

7. All recordings shall have location (*i.e.* manhole # to manhole #), time, date, and footage displayed.

8. Recording media shall be digital video-disk (DVD) format.

9. All DVD's shall be legibly labeled with company, project, and pertinent televising information.

C. Test Failure. Representatives from the Town shall review the video and determine if any defects, low spots and high spots, or similar problems exist. Sections of the pipe which have been identified as improper shall have the defects repaired and the test repeated.

3.7 DEFLECTION TEST

A. When required by the Town Engineer or the Town's Sewer Department, all sanitary sewers constructed of flexible pipe may be tested for deflection not less than thirty (30) days after the trench backfill and compaction operation have been completed and accepted.

B. At least thirty (30) days shall have elapsed from the last air test before deflection testing.

C. The deflection shall be tested in the requested sections by the Contractor with a Pin-Type Go-No-Go Gauge, set at ninety five (95%) percent of the diameter of the pipe being tested.

D. The test shall be performed on a manhole to manhole basis.

E. Unsatisfactory test results may be cause for rejection and the failed areas shall be repaired and retested.

3.8 SMOKE TEST

A. When required by the Town Engineer or the Town's Sewer Department, sanitary sewer systems may be required to pass a smoke test.

B. The test shall be preformed after backfill operations have been completed and accepted.

C. The Contractor shall supply the necessary smoke testing apparatus and shall conduct the test after the pipeline has been cleaned and prepared.

D. If the tests reveal cracks or breaks in the pipeline, or improper connections made, the Town Engineer may require additional tests or replacement/repair.

E. The Town Engineer shall be the sole judge of test results. Unsatisfactory test results may be cause for rejection.

END OF SECTION

SECTION 03310

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for cast-in-place concrete such as concrete for manholes, vaults, thrust blocks, cut-off walls, and encasements used in potable water distribution and sanitary sewer collection systems within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of cast-in-place concrete in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or, with prior approval, as established in the field.

All cast-in-place concrete materials shall be furnished complete in place with all forms, cement, aggregate, water, reinforcing steel, curing compounds, and includes transporting, placing, consolidating, finishing, curing, backfilling, compacting and other appurtenant work.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. Mix Designs. The Contractor/Owner shall furnish to the Town Engineer concrete mix designs meeting the requirements of these Standards a minimum of five (5) working days prior to intended use of the mix. The mix design shall be reviewed and accepted by the Town Engineer prior to use. If a mix design not accepted by the Town is used, the Town may require removal of all improvements placed with the unaccepted material.

   Mix Design requirements may be waived by the Town Engineer (in writing), when in his opinion, this prerequisite is not a necessity for the particular project.

B. Test Reports. Test reports submitted to the Town shall include all tests performed on the project. Reports shall bear the seal and signature of a Professional Engineer registered in the State of Colorado and competent in the required testing practice. All test reports shall show the location where the test was performed or at which the work or batch represented by the test was located.

   Test reports shall include all information specified in the AASHTO, ASTM, CDOT, or Colorado Test Procedure used. Improperly completed reports will not be accepted. Acceptance will not be complete until all final reports indicating compliance with these specifications are reviewed and placed on file by the Town.

C. Warranty Period. The warranty period for the completed non-structural concrete appurtenances cannot start until all required test reports, record drawings, inspection reports, and other documentation are submitted in the proper format and accepted by the Town.

   The Contractor/Owner shall guarantee manholes, vaults, cut-off walls, thrust blocks, and encasements, for the warranty period after completion against defective workmanship and materials and shall keep the same in good order and repair.

   The determination of the necessity, during such guarantee period, for the Contractor to repair any concrete work or any portion thereof, shall rest entirely with the Town Engineer, whose decision upon the matter shall be final and obligatory upon the Contractor.

D. Quality Control Testing and Reporting Procedures. All testing methods and procedures performed by the Geotechnical Engineer personnel shall be done in accordance with the applicable AASHTO, ASTM, ACI, or Colorado Procedure requirements and procedures, as specified. Test reports shall include the

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AASHTO, ASTM, ACI, and Colorado Procedures (CP) test designations of all tests taken. All testing and retesting services shall be done at the expense of the Contractor/Owner.

When changes in materials or proportions are encountered during construction, or when the work fails to pass tests or fails to meet these Standards, additional tests shall be taken as directed by the Town Engineer. Failure of the Contractor/Owner to furnish satisfactory test data shall be sufficient cause for rejection of the work in question.

E. Testing Program.

1. Specification. All testing shall be done in accordance with AASHTO, ASTM, ACI or Colorado Procedures (CP), as designated throughout this section and in accordance with **Table 03310-1**, **Material Testing**, below. Concrete that does not meet compressive strength in twenty eight (28) days is subject to removal.

Table 03310-1
Material Testing

Portland Cement Concrete	AASHTO	ASTM	Frequency
Sampling	T141	C172	
Mold & Cure	T23	C31	
Transportation of cylinders	T23	C31	
Slump	T119	C143	First 3 loads each day
Temperature		C1064	First 3 loads each day
Air Content:			
Pressure	T152	C231	1/50 cy
Volume	T196	C173	
Gravimetric	T121	C138	
Concrete Cores:		C174	
Obtaining Cores	T24	C42	
Compressive Strength	T22	C39	4 cylinders per 100 cy
Air Content		C457	
Cement Content	T178	C85	

2. Concrete Testing.

a. Sampling and testing shall be required on concrete work for cast-in-place manholes and vaults.

b. Maximum time allowed between sampling and casting cylinders shall not exceed ten (10) minutes. If the concrete cannot be taken to the laboratory and cylinders cast within fifteen (15) minutes, the cylinders shall be cast in the field. Cylinders shall be transported to the laboratory within forty eight (48) hours of casting but after the concrete has hardened, (see AASHTO T23). For acceptance testing at specified compressive strength, cylinders shall be six (6") inches in diameter by twelve (12") inches tall or four (4") inches in diameter by eight (8") inches tall.

c. The slump and air content tests shall be performed in accordance with **Table 03310-1**, **Material Testing**, above. Slump and air content test measurements shall be taken with each cylinder series. Concrete design criteria and slump and air content shall be done in accordance with CDOT Table 601-1. Concrete for non-structural concrete appurtenances shall conform to the following requirements:

i. Concrete Strength. The furnished concrete shall have a minimum twenty eight (28) day compressive strength of thirty five hundred (3500 psi) pounds per square inch.

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ii. Water/Cement Ratio. The concrete furnished shall have maximum water/cement ratio of forty five hundredths (0.45).

d. Concrete cylinders shall be load-tested and broken at the times listed in **Table 03310-2**, **Concrete Cylinder Breaks**, below:

Table 03310-2
Concrete Cylinder Breaks

Number of Cylinders (Series of four)	**Break Interval (Days)**
1	7
2	28
1	56

NOTE: Additional cylinders may be required, as directed by the Town Engineer. 56-day cylinder used if 28-day cylinder strength less than required design strength.

e. Compressive Strength Cylinders. At least four (4) compressive strength cylinders shall be taken from the same concrete delivery truck to provide design compliance testing at the laboratory. Two (2) of the four (4) specimens will be tested at twenty eight (28) days for acceptance and one (1) shall be tested at seven (7) days for information. The fourth (4th) cylinder shall only be necessary if the twenty eight (28) day fails. This is required for each pour per day with at least one (1) strength test series for each fifty (50 cy) cubic yards of concrete placed. Additional cylinders may be required to determine the rate of strength gain on high-early concrete mixes.

f. Other Tests. Slump, water/cement ratio, air content, unit weight, and mix temperature shall be tested for each pour per day with at least one (1) test for each fifty (50 cy) cubic yards of concrete placed.

g. Low Strength Test Results. If the compressive strength of cylinders and beams does not meet the specified values, the Design and/or Testing Engineer shall recommend and the Town Engineer shall approve the necessary mitigation measures needed.

i. The Town Engineer and Testing laboratory shall determine the areas of concrete with potentially low strength and clearly denote the areas to the Contractor/Owner.
ii. The Contractor/Owner shall have an independent testing laboratory, acceptable to the Town Engineer, obtain and cure core samples per ASTM C42 or AASHTO T24. A minimum of three (3) samples shall be taken for each one hundred (100 cy) cubic yards or fraction thereof of concrete in question.
iii. Concrete in the area represented by the core tests shall be considered to have adequate strength if the average of the three (3) cores is equal to at least ninety one (91%) percent of the design compressive strength and no single core is less than eighty five (85%) percent. To check testing accuracy, locations represented by erratic core strengths may be retested.
iv. If the concrete is determined not to have adequate strength, the Town Engineer may require the low strength areas to be replaced.

h. Coring. Coring is not generally permitted unless approved by the Town Engineer and, if approved, the section cored shall be repaired to the Engineer's satisfaction.

F. Concrete Mix Design. Concrete mix design shall be performed in accordance with the provisions of CDOT Specifications 601.05. A separate mix design shall be provided if pumped concrete is to be used. Mix designs shall be submitted no less than five (5) working days prior to placement of any concrete.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D., and as modified herein:

A. Batching. Measuring and batching of materials shall be done at a batching plant in accordance with AASHTO M157 and shall be in accordance with the provisions of CDOT Specifications 601.06.

B. Mixing. Mixing of all concrete products shall be performed be in accordance with the provisions of CDOT Specifications 601.07.

C. Air Content Adjustment. When a batch of concrete delivered to the project site does not conform to the minimum specified air content, an air entraining admixture conforming to CDOT Specification 711.02, may be added, one (1) time only for the batch, at the Contractor's option prior to consideration for rejection. After the admixture is added the concrete shall be re-mixed for a minimum of twenty (20) revolutions of the mixer drum at mixing speed. The concrete shall then be re-tested and if found acceptable may be placed in accordance with the specifications. A maximum of three (3) batches per day may be adjusted by adding air entraining admixture at the delivery site.

PART 2 – MATERIALS

2.1 CONCRETE

Concrete shall be composed of cement, coarse and fine aggregate, water, and entrained air. The concrete shall contain a minimum of six (6) sacks of cement per cubic yard or an equivalent cement/fly ash combination not to exceed twenty (20%) percent cement replacement (when approved), a maximum of five (5 gal) gallons of water per sack of cement, an air content between five (5%) percent and eight (8%) percent by volume, and a maximum coarse aggregate size of one and a half (1½") inches.

Any admixture (except air entraining agent) must be approved by the Town Engineer. Other high-early strength concretes may be used only where special conditions warrant, subject to written approval by the Town Engineer.

2.2 PORTLAND CEMENT

Portland cement shall comply with the CDOT requirements. The type of cement shall be Type II, unless sulfate conditions necessitate otherwise. ACI 201 indicates recommendations for sulfate resistance.

2.3 FINE AGGREGATES

Fine aggregates for Portland Cement non-structural concrete appurtenances shall meet CDOT Specifications 703.01, CDOT Table 703-1 and **Table 03310-3**, **Fine Aggregates for Portland Cement Concrete**, below:

Table 03310-3
Fine Aggregates for Portland Cement Concrete

Sieve Size or Test Procedure	Percent Passing or Test Requirement
Friable Particles, %	1.0%, Maximum
Coal and Lignite, %	1.0%, Maximum
Deleterious Material (AASHTO T-11), %	3.0%, Maximum
Sand Equivalent (AASHTO T176), %	80%, Minimum
Fineness Modulus	2.50 – 3.50
Sodium Sulfate Soundness, %	20.0%, Maximum

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2.4 COARSE AGGREGATES

Coarse aggregates for Portland Cement non-structural concrete appurtenances shall meet the requirements of CDOT Specifications 703.02 and **Table 03310-4**, **Coarse Aggregates for Portland Cement Concrete**, below:

Table 03310-4
Coarse Aggregates for Portland Cement Concrete

Sieve Size or Test Procedure	Percent Passing or Test Requirement
2"	100%
1-1/2"	95% - 100%
3/4"	35% - 70%
3/8"	10% - 30%
#4	0% - 5%
#200	1.0%, Max. (1.5% if crusher fines)
% Wear	45.0%, Maximum
Clay Lumps and Friable Particles, %	2.0%, Maximum
Coal and Lignite, %	0.5%, Maximum
Sodium Sulfate Soundness, %	12.0%, Maximum

2.5 FLY ASH

Fly ash for Portland Cement concrete pavements shall comply with CDOT Specifications 701.02.

2.6 WATER

Water for Portland Cement concrete pavements shall meet the requirements of CDOT Specifications 712.01.

2.7 AIR ENTRAINING AND CHEMICAL ADMIXTURES

A. Air entraining and chemical admixtures for Portland Cement concrete pavements shall meet the requirements of CDOT Specifications 711.02 and 711.03. No additive manufactured with the purposeful addition of chloride shall be permitted. Water-reducing admixtures are used when concrete temperatures are as follows: Type A is used between fifty (50° F) degrees and ninety (90° F) degrees Fahrenheit; Type D is used when over ninety (90° F) degrees Fahrenheit.

B. Additives for concrete, other than those specified in the mix design, shall not be used without prior written approval of the Engineer. When approved for use, chemical admixtures or additives shall comply with applicable ASTM or AASHTO standards. Application of admixtures shall be as per manufacturer's specifications.

C. Coloring for colored concrete shall be accomplished by the addition of an approved commercially pure or synthetic mineral pigment as specified in the contract documents.

2.8 CONCRETE REINFORCEMENT

A. All deformed reinforcing bars (rebar) shall conform to ASTM A615 or ASTM A617. All rebar shall be grade sixty (60) unless otherwise approved.

B. All welded wire fabric shall conform to ASTM A185.

2.9 CURING MATERIALS

Curing materials for Portland Cement non-structural concrete appurtenances shall meet the requirements of CDOT Specifications 711.01.

2.10 MIX DESIGN

A. All concrete shall be ready mixed concrete. Concrete mix designs consist of selecting the aggregates appropriate for the concrete application, and performing a mix design to determine the properties of the proposed mix. The proposed mix shall be tested in accordance with ACI code requirements. The Contractor must submit one (1) mix design per each concrete type intended for use within the public rights-of-way at the start of each calendar year. **No concrete shall be placed prior to the submittal of such mix designs.**

B. Concrete for manholes and vaults may be fiber reinforced. The fibers shall be between three quarter to one (¾" - 1") inch in length and shall be used at a rate of one and a half (1½ lbs/cy) pounds of fibers per cubic yard of concrete.

2.11 EXPANSION JOINT MATERIAL

Expansion joint material shall be non-extruding preformed joint filler and shall conform to ASTM Specification D1751 or D1752 or AASHTO M-59.

2.12 JOINT SEALER

Joint sealer material shall be Sikaflex or approved equal, TT-S-00230C, Type II, Class A, ASTM Specification C-920 Type S, Grade NS, Class 25.

PART 3 – EXECUTION

3.1 WEATHER LIMITATIONS

A. Hot Weather Limitations. Placing of concrete during hot weather shall be limited by the temperature of the concrete at the time of placing. Mixed concrete which has a temperature of ninety (90° F) degrees Fahrenheit or higher, shall not be placed. The Contractor shall provide fogging equipment and keep the concrete surface moist at all times by fogging with an approved atomizing nozzle until the curing material is in place.

The aggregate stockpiles shall be kept moist at all times

B. Cold Weather Limitations.

1. The Contractor is responsible for the strength and quality of the concrete placed during cold weather. Before starting non-structural concrete appurtenance construction operations, the Contractor shall be prepared to protect the concrete from freezing. Maturity meters, to monitor and record time and pavement temperature, may be required to be installed at the time of placement when the air temperature is expected to fall below forty (40° F) degrees Fahrenheit during the next three (3) days or as requested by the Engineer when the air temperature is expected to fall below forty five (45° F) degrees Fahrenheit during the next three (3) days. The Contractor shall maintain the temperature of the non-structural concrete appurtenances at or above forty (40° F) degrees Fahrenheit until they have attained a compressive strength of at least two thousand (2,000 psi) pounds per square inch. The compressive strength of the concrete shall be determined by the use of maturity meters. Maturity meters shall meet the requirements of CDOT Specifications 412.15.

2. Concrete shall not be placed on frozen ground. Before concrete placement, all ice, snow, and frost shall be completely removed from within formwork. Salt shall not be used to thaw ice, snow, or frost.

3. The mixed concrete temperature shall be between fifty (50°) degrees and ninety (90° F) degrees Fahrenheit at the time of placement. Water, aggregates, or both shall be heated when necessary,

under such control and in sufficient quantities to avoid fluctuations in the temperature of the concrete of more than ten (10° F) degrees Fahrenheit from batch to batch.

4. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding one hundred fifty (150°) degrees F. Materials containing frost or lumps of frozen material shall not be used.

5. Electrically heated curing blankets or insulation blankets may be used in cold weather to maintain specified curing temperature and to retain moisture in concrete. Blankets shall be lapped at least eight (8") inches and shall be free of holes. Blankets shall be secured at laps and edges to prevent moisture from escaping.

3.2 PLANNING AND PREPARATION

A. Non-structural concrete appurtenance construction requires careful planning and preparation. The surface course or base course must be properly prepared. Enough vehicles and equipment, in good operation, and adequate, trained personnel must be available to provide a steady flow of materials and progress without delays. Batch plant production must be closely coordinated with the operation.

B. Before placing operations, the engineer and inspectors should confer with the Contractor's superintendents and foremen and carefully plan the entire operation. Some important details that should be discussed include:

1. Continuity and sequence of operations,
2. Number and description of equipment needed for the project,
3. Number of mixer trucks required,
4. The chain of command for giving and receiving instructions,
5. Reasons for possible rejection of the mix,
6. Weather and temperature requirements, and
7. Traffic control.

3.3 EQUIPMENT

Equipment and tools shall be capable of handling materials, performing the Work, producing a product of specified quality, and shall be approved. The equipment shall be at the job site sufficiently ahead of the start of placing operations to be examined and approved.

A. Hauling Equipment. Concrete may be hauled and placed with non-agitator equipment. Bodies of non-agitating equipment shall be smooth, mortar tight containers, and shall be capable of discharging the concrete at a controlled rate without segregation.

B. Consolidating and Finishing Equipment. Concrete may be spread, struck-off and finished by hand, either from fixed forms or by slip form method, unless otherwise permitted. Consolidation shall be accomplished by vibrators for the full width of the work. The vibrators shall be the internal type meeting the requirements of CDOT Specifications 412.07(b).

C. Concrete Saw. When sawed joints are required, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimension and at a rate that will control cracking. The Contractor shall provide at least one (1) standby concrete saw in good working order at all times. An ample supply of saw blades shall be maintained at the site of the Work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of the equipment shall be on the job during concrete placement. Wastewater generated from concrete saw operations shall be contained and disposed of in an approved manner.

3.4 BATCHING

Batching of concrete shall conform to CDOT Standard Specifications, Section 601.06.

3.5 MIXING

A. Mixing of concrete shall conform to CDOT Standard Specifications, Section 601.07.

B. The Contractor shall submit to the Town the ready mix delivery ticket for each load upon request by the Town indicating the following:

1. Supplier's name and date.
2. Truck number.
3. Project number and location.
4. Concrete class designation.
5. Cubic yards batched.
6. Mix design identification.
7. Type, brand, and amount of cement.
8. Brand and amount of all admixtures.
9. Weights of fine and coarse aggregates.
10. Moisture content of fine and coarse aggregates.
11. Gallons of batch water.
12. Time at which water was added.
13. Elapsed time between when water was added and concrete load was in place.
14. Amounts of initial water and the maximum number of gallons of supplemental water allowed to be added for each truck at the job site.
15. Name of individual authorizing supplemental water.
16. Numerical sequence of delivery by indicating cumulative yardage delivered on each ticket.
17. Provide the following titles with blank space to record discharge time, water-cement ratio, air content, slump, and revolutions.

3.6 PREPARATION OF SUBGRADE

A. Subgrade Preparation. Subgrade preparation shall conform to the lines, grades, cross-sections, and thickness shown on the approved Construction Drawings, shall be scarified and compacted, and level.

B. Bedding. Bedding for manholes and vaults shall be compacted granular material as specified on the Construction Drawings and as directed by the Town Engineer.

C. Foundation. If in the opinion of the Town, the foundation soil is of such character that it will swell or shrink with changes in its moisture content to such an extent that the concrete may be damaged; the soil shall be excavated as directed by the Town, refilled, and compacted with material which meets the requirements of these specifications.

D. Conformity. The subgrade and/or sub-base shall be brought to a firm and unyielding condition with a uniform density. All soft and yielding material and other portions of the subgrade that will not compact readily when rolled or tamped shall be removed and replaced with suitable material. Concrete shall not be placed on a soft, spongy, frozen, or otherwise unsuitable subgrade. Before placing any concrete, the subgrade shall be tested for conformity with the cross-section shown on the plans, using an approved template, or other approved method. The finished subgrade shall be kept smooth, damp, and compacted prior to placing concrete.

E. Subgrade. Prior to constructing the infrastructure, the area beneath the structure should be brought to plus or minus two (± 2") inches of finished subgrade to accept the bedding material.

3.7 FORMS

A. Design.

1. Forms shall be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incidental to the concrete operations, including vibration.

2. The rate of depositing concrete in forms shall be controlled to prevent deflections of the form panels in excess of the deflections permitted by these specifications.

3. Forms for manholes and vaults may be constructed of any suitable material that will produce a structure with the inside dimensions and at least the wall thicknesses shown on the plans. Undulation of finished interior wall surfaces shall not exceed one half (0.5") inch.

B. Material.

1. Forms shall be made of wood, metal or other material as approved by the Town Engineer.

2. Approved flexible forms shall be used for construction where the radius is two hundred (200') feet or less. Unexposed surfaces shall have wood forms of No. two (#2) common (or better) lumber.

3. Metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms shall be free from rust, grease or other foreign matter

C. Construction.

1. Forms shall be constructed and maintained so as to prevent the opening of joints due to shrinkage of the lumber. The use of ties consisting of twisted wire loops to hold forms in position will not be permitted.

2. The inside surfaces of forms shall be cleaned of all dirt, mortar, and foreign material. Forms which will later be removed shall be thoroughly coated with form oil prior to use. The form oil shall be a commercial quality form oil or other equivalent coating which will permit the ready release of the forms and will not discolor the concrete.

3. Forms which do not present a smooth surface or do not line up properly shall not be used.

4. Forms shall have a depth equal to or greater than the specified edge thickness of the concrete, without horizontal joints exceeding four (4′) feet.

5. Top surface of the forms shall be set flush with the proposed concrete surface. The top face of the form shall not vary from a true plane by more than one eighth (1/8") inch in ten (10') feet, and the vertical leg shall not vary more than one quarter (1/4") inch from vertical.

6. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be staked securely to line and grade to the satisfaction of the Engineer.

7. Concrete shall not be deposited in the forms until all work connected with constructing the forms has been completed; all materials required to be embedded in the concrete have been placed, unless otherwise specified on the plans or approved; and the Engineer has inspected said forms and material. Such work shall include the removal of all dirt, chips, sawdust, water and other foreign material from the forms.

D. Removal of Forms.

1. The forms for any portion of the non-structural concrete appurtenance shall not be removed until the concrete is strong enough to withstand damage when the forms are removed.

2. Removal of forms shall not occur before twelve (12) hours after concrete pour. When the ambient temperature is below forty (40° F) degrees Fahrenheit, the time shall be twice that duration.

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3. If high-early-strength (Type III) cement or accelerating admixtures are used, the above periods may be reduced as approved.

3.8 CONSTRUCTION OF WATERLINE MANHOLES AND VAULTS

A. Construction requirements for waterline manholes and vaults shall conform to **Section 02280, Waterline Manholes and Vaults**, except as modified by these specifications.

B. All cast-in-place concrete waterline manholes and vaults shall be constructed with a minimum eight (8″) inch wall thickness, reinforced with welded steel wire fabric.

C. Where a section of adjacent concrete sidewalk, curb and gutter, valley gutter, bikeways, driveway, or alley approach has been disturbed, it shall be removed to a joint, if the joint is situated within five (5') feet of the proposed or existing cut, otherwise a full depth straight line shall be saw cut prior to replacement.

D. Where new construction abuts existing, the work shall be accomplished so that the variance in grade between the old and new work does not exceed one quarter (¼") inch.

3.9 CONSTRUCTION OF SEWER LINE MANHOLES

A. Construction requirements for sewer line manholes and vaults shall conform to **Section 02450, Sewer Line Manholes**, except as modified by these specifications.

B. All cast-in-place concrete sewer line manholes shall be constructed with a minimum eight (8″) inch wall thickness, reinforced with welded steel wire fabric or rebar as shown on the approved Construction Drawings.

3.10 PLACING CONCRETE

A. Construction Stakes.

1. The Contractor/Owner shall provide all construction stakes required for manholes, vaults, cut-off walls, thrust blocks, and encasements and will furnish all necessary information relating to lines and grades.

2. The Contractor shall be held responsible for the reasonable preservation of all such stakes.

3. The Contractor shall not remove stakes until three (3) working days after placement of the concrete unless approved by the Town.

4. Temporary grade pins, or screed points, used to establish flowline or base elevation, shall be removed from the concrete prior to curing.

B. Placing Concrete.

1. Concrete shall be placed using fixed forms.

2. The alignment and grade elevations of the forms shall be checked by the Contractor immediately ahead of concrete placement and necessary corrections will be made. Any forms that have been disturbed or subgrade that has become unsuitable shall be corrected, forms reset, and rechecked. Any variations in grade and alignment shall be subject to approval by the Town prior to placing the concrete.

3. Forms shall be oiled prior to placement of concrete.

4. The subgrade shall be moist but not wet prior to placing concrete. After the Town has approved the forms and subgrade, the concrete shall be deposited on the subgrade to the required depth and thickness in successive batches and in a continuous operation. The concrete shall be placed as uniformly as possible to minimize the amount of spreading necessary. Reasonable care shall be taken to prevent any segregation of the concrete materials and the displacement of any reinforcement.

5. Concrete shall not be dropped more than five (5') feet, unless confined by closed chutes or pipes. Concrete shall be placed in lifts not to exceed eighteen (18") inches, unless directed otherwise by the Town Engineer.

6. While being placed, the concrete should be consolidated or vibrated with suitable tools to prevent the formation of voids or honeycomb. Any evidence of lack of consolidation shall be regarded as sufficient reason for requiring the removal of the section involved and its replacement with new concrete. The Contractor shall be responsible for any defects in the quality and appearance of the completed work.

7. All curves with radii less than two-hundred (200') feet shall be constructed with flexible forms.

8. Flat-top lids for vaults shall have adequate lifting devices installed during their construction to enable future removal for access to waterline appurtenances.

9. No low spots, which cause water to pond, will be acceptable.

10. Cast-in-place manholes and vaults shall be formed and placed true to line, grade, and cross section. The finished surface must be straight and true to within one-quarter (1/4") inch along any ten (10') foot length of the new concrete in the vertical or horizontal plane.

C. Vibrating.

1. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies by means of suitable mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate consolidation.

2. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and imbedded fixtures and into corners and angles of the forms. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form.

3. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish consolidation, with care taken to bring only a continuous film of mortar to the surface, but shall not be prolonged to the point where segregation occurs.

4. Any evidence of lack of consolidation or over-consolidation shall be regarded as sufficient reason for requiring the removal of the section involved and its replacement with new concrete at the Contractor's expense.

5. Following placement, the concrete shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the appurtenance will be at the elevation shown on the plans or established in the field.

3.11 FINISHING CONCRETE

A. Finishing.

1. After the concrete has been placed and consolidated in the forms, it shall be finished. A wood float shall be used to bring the surface of the concrete to its final form; excessive working of the surface

will not be permitted. The Contractor is cautioned against the use of a steel trowel for floating the finished concrete. This practice can excessively seal and trap moisture beneath the surface. Premature surface spalling may occur. Repair of such spalling will be the Contractor/Owner's responsibility.

2. The final texture of all exposed surfaces shall be obtained by light brooming.

3. After completion of brooming and before the concrete has taken its initial set, all edges in contact with the forms shall be tooled with an edger having a one-quarter (¼") inch radius. No dusting or topping of the surface or sprinkling with water to facilitate finishing will be permitted.

4. Wastewater generated from concrete finishing operations shall be contained and disposed of in an approved manner.

B. Removal of Forms. Removal of forms shall not occur before twelve (12) hours after concrete pour. When the ambient temperature is below forty (40° F) degrees Fahrenheit, the time shall be twice that duration.

3.12 JOINTS

A. Expansion Joints. Expansion joints shall be required as shown on the approved Construction Drawings and where new concrete abuts existing structures, fire hydrants, poles, sidewalks, and other fixed objects.

1. Expansion joints, where required, shall be filled with one-half (½") inch thick, full depth, preformed expansion joint material as per CDOT Standard Specifications, Subsection 705.01.

2. Expansion joint material must be set vertical and with the top edge three quarter (¾") inch below the finished surface. The joint shall be edged with a one-quarter (¼") inch radius edging tool.

3. All expansion joints shall be caulked as per Details with approved joint sealing material.

3.13 CURING

Immediately after the finishing operations have been completed, the entire surface, and exposed sides of the newly placed concrete, shall be sprayed uniformly with an impervious membrane curing compound. The impervious membrane curing compound shall meet the requirements of AASHTO M148, Type 2 and shall be volatile organic content (VOC) compliant. The new concrete shall not be left exposed for more than thirty (30) minutes before being covered with curing compound. Failure to cover the surface of the concrete within the thirty (30) minutes shall be cause for immediate suspension of the concreting operations. The freshly placed concrete shall be protected from premature drying and excessive cold or hot temperatures as well as rain, flowing water, and mechanical injury. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporative-control material.

A. Curing compound shall be applied under pressure by mechanical sprayers at the rate of not less than one (1) gallon per one hundred fifty (150 ft^2) square feet of concrete surface. Curing compound may be applied in two (2) passes, one forward and one backward. The spraying equipment shall be fully atomized, equipped with a tank agitator, and a wind guard. During application, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle and the compound shall be stirred continuously by effective mechanical means. Hand spraying of irregular widths or shapes and surfaces exposed by removal of forms may be permitted. Curing compounds shall not be applied to the inside faces of joints to be sealed.

B. Should the curing film become damaged from any cause, within seventy two (72) hours after application, the damaged portions shall be repaired immediately with additional compound.

C. The sides of concrete exposed when the forms are removed shall be immediately sprayed with curing compound.

D. The minimum curing period shall be one hundred twenty (120) hours. The coating shall be protected against marring. Any coating marred, or otherwise disturbed, shall be given an additional coating.

E. It shall be the Contractor's responsibility to protect the concrete being cured from the elements, traffic, and vandalism.

F. The Contractor is responsible for the strength and quality of the concrete placed during cold weather. When the ambient temperature is below thirty five (35° F) degrees Fahrenheit, the Contractor shall maintain the concrete temperature above fifty (50° F) degrees Fahrenheit during the curing period. It is the Contractor's responsibility to determine the necessity for undertaking protective measures.

3.14 THRUST BLOCKS AND ENCASEMENT INSTALLATIONS

All thrust blocks and encasements constructed of concrete within public right-of-way shall conform to the requirements of these Construction Specifications, **Section 02220, Waterline Pipe Installation**, Subsection 3.5, Thrust Restraint.

3.15 CONCRETE CUT-OFF WALLS

Concrete cut-off walls shall conform to the requirements of these Construction Specifications, **Section 02210, Trenching, Backfill and Compaction**, Subsection 2.5 and 3.5, Groundwater Barriers.

3.16 PROTECTION/DEFACED/DAMAGED OR DEFECTIVE CONCRETE

A. Limitations. The Contractor shall be responsible for taking adequate steps to protect concrete placed during precipitous, hot, or cold weather. Limitations on the placing and protecting of concrete shall conform to these specifications. Any concrete damaged by precipitation or extreme temperatures or otherwise defective shall be removed and replaced at the Contractor/Owner's expense.

B. Potential Frost Damage. The following procedures shall be followed if the temperature of the surface of the concrete falls below thirty two (32º F) degrees Fahrenheit before the concrete reaches the required compressive field strength of thirty five hundred (3500 psi) pounds per square inch.

1. The Contractor will take cores at locations designated by the Town.

2. The Town will take immediate possession of the cores and submit the cores to a petrographer for examination in accordance with ASTM C 856. Concrete damaged by the frost as determined by the petrographic examination shall be removed and replaced at the Contractor's expense.

3. All costs associated with coring, transmittal of cores, petrographic examination, and reports shall be born by the Contractor regardless of the outcome of the petrographic examination.

3.17 BACKFILLING

Once the concrete has gained sufficient strength to not be damaged, the space adjoining the concrete shall be backfilled with suitable material, properly compacted, and brought flush with the surface of the concrete and adjoining ground surface.

3.18 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in **Section 01010, Summary of Work**, Subsection 1.3.J; except subsection 1.3.J. shall be modified to include the following:

A. Mix Design.

The Contractor shall submit a Concrete Mix Design Report consisting of design mix proportions, laboratory trial mix and aggregate data for each class of concrete being placed on the project when requested by the Town Engineer or Construction Inspector. Concrete shall not be placed on the project

before the Concrete Mix Design Report has been reviewed and approved by the Town Engineer. The design mix proportions shall show the weights and sources of all ingredients including cement, fly ash, aggregates, water, additives and the water cement ratio (w/c). When determining the w/c, cement (c) shall be the sum of the weight of the cement, the weight of the fly ash and the weight of silica fume. The laboratory trial mix data shall include results of all the information requested in CDOT Standard Specifications 601.05. Mix Design requirements may be waived by the Town Engineer (in writing), when in his opinion, this prerequisite is not a necessity for the particular project.

B. Field Acceptance Tests.

These provisions apply to all concrete placed for manholes and vaults, or when directly requested by the Town Engineer or Construction Inspector:

1. Air Content. At any time during the placement of the concrete, when a batch deviates from the minimum or maximum percent of total air content by more than one (1%) percent, the entire batch shall be rejected.

2. Slump. At any time during the placement of the concrete, when a batch deviates from the maximum slump specified by more than one and one half (1½") inch, the entire batch shall be rejected. Portions of loads incorporated into structures prior to determining test results which indicate rejection as the correct course of action shall be subject to acceptance or removal as determined by the Engineer.

3. Strength. The concrete will be considered acceptable when the running average of three (3) consecutive strength tests is equal to or greater than the specified strength and no single test falls below the specified strength by more than five hundred (500 psi) pounds per square inch.

   a. A test is defined as the average strength of three (3) test cylinders cast in plastic molds from a single sample of concrete and cured under standard laboratory conditions prior to testing. If the compressive strength of any one (1) test cylinder differs from the average by more than ten (10%) percent, that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two (2) cylinders.

   b. When the compressive strength test is below the specified strength by more than five hundred (500 psi) pounds per square inch but not more than one thousand (1,000 psi) pounds per square inch, the concrete represented will be evaluated by the Town Engineer for removal, corrective action, or acceptance. When the compressive strength is below the specified strength by more than one thousand (1,000 psi) pounds per square inch, the concrete represented shall be rejected.

   c. The Contractor/Owner may take cores at its own expense and in accordance with Colorado Procedure 65 to provide an alternative determination of strength.

C. Testing Frequency.

Testing shall be performed by an independent testing company acceptable to the Town and results shall be provide to the Town Engineer within two (2) working days of completion of testing and prior to the next phase of construction. Testing shall be performed according to the schedule given in **Table 03310-5, Minimum Testing Frequency**, given below:

Table 03310-5
Minimum Testing Frequency

ITEM	TYPE OF TEST	MINIMUM FREQUENCY
All Excavation Backfill		
Backfill	Moisture/Density (Compaction Test)	1 per structure, per vertical foot of fill, min, 2 tests per lift.
Manholes & Vaults		
Soil Testing	Moisture/Density (Compaction)	1 test per vert. foot, min. 2 per lift
Concrete Testing	Air and Slump	1st 3 loads, every 5th load thereafter
	Cylinders	1 set of 4 per 100 cy, or fraction of.

D. Waiver for Small Loads.

If, in the opinion of the Engineer, the Work consists of a minor project, less than five (5 cy) cubic yards of concrete for the entire project, the testing procedures described above may be waived.

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SECTION 03340

PRE – CAST CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

The Work covered by this section includes materials specification and installation procedures for pre-cast concrete structures such as manholes, grade adjustment rings, vaults, flat slab tops, and wet wells, within the Town of Windsor and includes the acceptable materials and construction practices which may be used in the installation of cast-in-place concrete in accordance with these specifications and in conformance with the lines, grades, typical cross sections, and details as shown on the approved Construction Drawings, or established in the field.

All cast-in-place concrete materials shall be furnished complete in place with all forms, cement, aggregate, water, reinforcing steel, and gaskets, and includes transporting, placing, backfilling, compacting and appurtenant work.

1.2 QUALITY ASSURANCE

Quality Assurance shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.C., and as modified herein:

A. All pre-cast concrete manholes, vaults, and appurtenances are subject to approval by the Town of Windsor Engineering Department and/or Sewer Department.

1.3 JOB CONDITIONS

Job Conditions shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.I.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

Product Delivery, Storage and Handling shall be as specified in these Construction Specifications, **Section 01010, Summary of Work**, Subsection 1.3.D. and as modified herein:

A. All pre-cast concrete parts shall be new and shall be handled, stored, and protected in a manner which will prevent damage to the materials.

PART 2 - MATERIALS

2.1 PRE-CAST CONCRETE PRODUCTS

A. Barrels, bases, cone sections, grade rings, flat slab tops of manholes, and wet wells shall conform to ASTM C478, and shall be made with Type V cement conforming to ASTM C150.

1. Unless written permission is obtained from the Town Engineer, flat slab tops shall be used on vaults.

2. Reference the Town's Standard Drawings, the approved Construction Drawings, and **Section 02450, Sanitary Sewer Manholes**, of these Construction Specifications, to determine when manholes shall be conical or flat-top manholes.

3. Cone sections shall be the eccentric type unless approved otherwise by the Department.

B. Grease, Sand and Oil Interceptors pre-cast sections shall conform to ASTM C478, and shall be made with Type V cement conforming to ASTM C150.

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C. Barrels, bases, cone sections, and flat slab tops for water meter pit bases, water meter vaults, and pre-cast concrete vaults shall conform to ASTM C478, and shall be made with Type I or II cement conforming to ASTM C150.

1. Water meter pit bases shall be four thousand (4,000 psi) pounds per square inch concrete with fiber reinforcing.

2. Provide a one (1″) inch drain hole in water meter pits.

D. Reinforcing materials shall conform to ASTM C478.

1. Rebar shall be Grade 60.

2. Minimum reinforcement for bases of manholes shall consist of welded wire fabric, 4x4 – "W4xW4", reference ASTM C478.

E. Fine and coarse aggregate shall conform to ASTM C33.

F. Water shall be free from objectionable quantities of silt, organic matter, alkali, salts, and other impurities.

G. Reference **Section 02450, Sanitary Sewer Manholes**, of these Construction Specifications, for specifications on mortar, grout, ring and cover, steps, and preformed plastic gaskets for sewer manholes.

H. Reference **Section 02280, Waterline Manholes and Vaults**, of these Construction Specifications, for specifications on ring and cover, steps, hinged access doors, vent pipes, sump pits, and preformed plastic gaskets for waterline manholes and vaults.

PART 3 – EXECUTION

3.1 CONSTRUCTION

A. All vaults, manholes, grade rings, wet wells, and other pre-cast concrete structures shall be set plumb and to grade and at the location indicated on the approved Construction Drawings.

B. Sections shall be joined using preformed plastic gaskets installed in accordance with manufacturer's recommendations.

C. Joints shall be clean, dry, and primed.

D. Lifting holes shall be filled with an approved non-shrink grout.

3.2 FIELD QUALITY CONTROL

Field Quality Control shall be as specified in **Section 01010, Summary of Work**, Subsection 1.3.J.

END OF SECTION

END OF DIVISION