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FORWARD

Revised 7/19/24

About the Town of Clayton, NC

The Town of Clayton is a municipal corporation serving the Town of Clayton and its Extraterritorial Jurisdiction (ETJ). Our services are funded entirely from our rates and fees, which reflect legal requirements to use the "cost of service" approach in setting rates, fees, and charges. The Town of Clayton provides services within a basic framework of State and Federal law and agreements with the Town and County regarding the extension and provision of public water and sewer services.

Manual Introduction

The Town of Clayton's *Manual of Specifications, Standards, & Design* (MSSD) has been compiled from state-of-the-art practices and methodologies, many of the current standards and practices used by the Town of Clayton, from improvement standards used in other areas of the State of North Carolina, and from applicable enabling legislation of the State of North Carolina. This manual was prepared to facilitate ease of use by both design engineers and contractors and to establish the minimum acceptable guidelines for design and construction of municipal streets, drainage systems, utilities, and their appurtenances. The minimum requirements specified herein for the Town of Clayton have been determined to be reasonable as applicable to the Town of Clayton. The manual was developed and prepared by Appian Consulting Engineers, PA, Rocky Mount, NC for the Town of Clayton, NC utilizing the copyrighted *Muni-Spec*© data base, modified to conform with the most current policies and practices of the Town of Clayton.

Manual format

This manual has been divided into four basic divisions and can be used either by printing out the manual from the CD or internet or utilized solely from the CD. The electronic version of the manual permits the user to navigate the manual by using the table of contents (all headings hyperlinked to the various elements of the manual), the various numerous hyperlinks provided throughout the document, and through the "search" or "find" commands on your computer.

Standard Specifications

The standard specification section includes the following sections:

- Measurement and Payment
- Earthwork,
- Trenching, Backfilling and Compaction of Utilities,
- Curb & Gutter, Driveways, & Sidewalks,
- Water Distribution,
- Sanitary Sewer
- Storm Drainage,
- Base Course and Paving
- Seeding, Sodding, and Groundcover

Standard Details

All structures, as well as a few non-structure type standards are high-quality drawings. Most of the standard details have been drawn in isometric and/or exploded views.

Standard Detail sections included in this manual:

- Common
- Streets and Sidewalks
- Water
- Sewer
- Storm Drainage
- Landscaping
- Boardwalk & Footbridge

Design
A design section has been provided which incorporates the following:

❖ Street Design
- AASHTO Guide for Design of Pavement Structures, 4th Edition with 1998 Supplement, or latest edition,
- ITE Trip Generation, 11th Edition, or latest edition,
- The applicable sections of the NCDOT Materials, and Test Unit, Asphalt QMS Manual, 2022 or latest edition.
- The applicable requirements specific to the Town of Clayton.

❖ Water and Sewer
- Regulatory requirements of the NCDEQ, Division of Water Resources,
  - NCAC Title 15A Subchapter 2T *Waste Not Discharged to Surface Waters,*
- NCDEQ, Division of Water Resources, *Rules for Governing Public Water Supply Systems*, NCAC Title 15A Subchapter 18C, Water Supplies,
- ASCE–Manuals of Reports on Engineering Practice-No. 60 "Gravity Sanitary Sewer Design and Construction,"
- The "Recommended Standards for Sewage Works" by the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, and
- The applicable requirements specific to the Town of Clayton.

❖ Stormwater Management
- Regulatory requirements of the NCDEQ, Division of Energy, Mineral, and Land Resources, Stormwater, Stormwater Program, *Stormwater Design Manual*,
- The applicable requirements specific to the Town of Clayton.

❖ Boardwalk and Footbridge Design Guide

Policy and Ordinance
Some of the relevant specific policies and ordinances have been referenced. However, it is the responsibility of the designer to contact the Engineering Director's office if he/she needs information or copies of project related policies and ordinances that are not included in this manual.

To the best of their ability, the authors have tried to ensure that the information presented here is correct and that the procedures are reliable. The execution of an engineering design; however, involves the judgment of the design engineer and only the engineer can ascertain whether a technique or item of information can be applied to a given situation. Ultimately, the design engineer is responsible for his/her design meeting the intent of this manual .

Copies of Manual

A digital copy of this manual may be purchased by contacting the Town of Clayton Town Engineer.

Jurisdiction

This edition of the MSSD will become effective on January 1, 2025 and shall be applicable to all new improvements and alterations in existing improvements lying within the regulatory jurisdiction of the Town of Clayton.

Variance or Modification

Any variances, alternate designs, construction methods and materials, not specifically prescribed herein, shall be subject to the approval of the Engineering Director.

Copyright

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INTRODUCTION TO DESIGN AIDS

The design section of this manual is intended as an aid for use in water and sewer design, flexible pavement design, and hydrologic and hydraulic analysis. While it is presumed that the user of this manual is basically familiar with the methods of analysis presented herein; in many cases, the manual may provide examples and detailed instructions for their development. An exception to this rule is the case where another source document is referenced that expounds upon the method in greater detail. In that case, the designer is directed to the source document.

The Town of Clayton recognizes the difficulty in accurately defining or predicting the dynamic properties of nature. There are numerous methods of analysis available and it is recommended that as many methods as may be appropriate be employed in the solution of a problem. Furthermore, in hydraulic design, the designer must give consideration towards economic, aesthetic, and environmental aspects of the given design.

To the best of their ability, the authors have tried to ensure that the information presented here is correct and that the procedures are reliable. The execution of an engineering design; however, involves the judgment of the designer and only he or she can ascertain whether a technique or item of information can be applied to a given situation.

Therefore, neither Appian Consulting Engineers, the Town of Clayton, nor any contributor accepts responsibility for any real or alleged error, loss, damage or injury resulting from the use of material contained herein.

Town of Clayton, NC
PRE-APPROVED MATERIAL/PRODUCT LIST

Revision: **Final**

Effective Date: January 1, 2025 Last Revised: 9/12/24

Contract Number: _____

LINKS TO SPECIFIC SEWER PRODUCTS

Aluminum Hatches
Ductile Iron Pipe (Gravity of FM's)
Coupling – Sewer Lines
Grade Rings - Concrete
HDPE Gravity Sewer Pipe
Magnetic Marker Balls
Manhole Boots
Manholes - Butyl Sealant
Manhole Iron Castings (includes mini-manhole for cleanouts)
Manholes, Precast
Manholes/Wetwells, Polymer
Manhole Sealant - Exterior
Manhole Step
Maxadapter, Point Repair
Pump Stations
PVC Pipe Force Mains – Mat'l
PVC Gravity Pipe & Fittings
Centrifugally Cast, Fiberglass-Reinforced Polymer Mortar Pipe (HOBAS)
Saddle
Services: Shroud in Ease'ts
Steel Encasement Pipe & Spiders
Vacuum & Air Release Valves
WyesYardHydrantsSewer

LINKS TO SPECIFIC WATER PRODUCTS

Aluminum Hatches
All-thread rod, Stainless Steel
Brass Pipe
Cast CouplingsDIPRestJtPipe
Copper Tubing
Corporation Stops
DIP-Push-On Joints
DIP TR Flex Restrained Joint
Ductile Iron Fittings
Fire Hydrants
Flanged Coupling Adapters
HDPE Pipe (Directional Boring)
Flushing Device - Automatic
Manholes, Precast
Meter Setters
Meter Boxes
Meters; Large - Compound
Meters; Small - Displacement
Pipe Locator Balls
Pipe Saddle Support Stand
PVC Water Pipe
Restraint Joint Glands
Stainless Steel Tapping Sleeve
Tapping Service Saddles
Tracer Wire - Copper
Valves - Air Release
Valves - Check
Valve Boxes
Valves – **DCV** Assemblies
Valves – **RPZ** Assemblies
Valves – ¼ Turn SS Ball
Valves – Large (2" and larger)
ValvesSmallValve Box Pad, Round
Warning Tape – Magnetic

LINKS TO SPECIFIC STREETS AND DRAINAGE PRODUCTS

ADA Truncated Domes
Concrete Grade Rings
Corrugated HDPE Pipe
CMPPipeConcrete Flared End Sections
Geotextile Fabrics
Iron Castings, CB's, DI's
Iron Castings, OTCB Casting
Manholes - Precast
Manhole Steps
Manhole Frame & Cover
Precast Concrete CB's, DI's
Polypropylene Pipe
Ram-Nek Joint Sealant
MHIronRiserRingsReinforced Concrete Pipe

Sanitary Sewer

PRE-APPROVED MATERIAL/PRODUCT LIST

Town of Clayton

PVC - Gravity Pipe

(Green)



Specification Section: 2530, paragraph 2.1.2. A

Standard Details: N/A

Standard:

- **Mains:** ASTM D3034 (8 inches – 15 inches); SDR 35; For 18-inch diameter PVC, comply with ASTM F679, Type PSM; ASTM F477
- **Services:** ASTM D1785, Sch 40, solid wall (4-inch and 6-inch)

Approved Manufacturer/Product	Supplemental Information	Type	Size
☐ Charlotte Pipe & Foundry Co.		☐ Main	8-inch through 15-inch
☐ Diamond Plastic Corporation		☐ Main	8-inch through 15-inch
☐ Harvel		☐ Main	8-inch through 15-inch
☐ JM Eagle		☐ Main	8-inch through 15-inch
☐ Sanderson Pipe Corporation		☐ Main ☐ Service	8-inch through 15-inch 4-inch through 6-inch
☐ Westlake Pipe & Fittings	Formerly North American Pipe Corp	☐ Main	8-inch through 15-inch

LINKS TO MANUFACTURERS:

- Charlotte Pipe & Foundry Co.: https://www.charlottepipe.com/pl_pvc_d3034_sewer_main.aspx
- Diamond Plastic Corporation: https://www.dpcpipe.com/docs/SANI-21-SD-35-26/Sani-21-SDR-Specifications.pdf
- Harvel: https://www.gfps.com/en-us/products-solutions/systems/schedule-40-cpvc.html http://www.harvel.com/piping-systems/gf-harvel-pvc-industrial-pipe
- JM Eagle: http://www.jmeagle.com/watersewer/gravity-sewer-pipe http://www.jmeagle.com/plastic-pipe/pvc-pipe/gravity-sewer.html
- Sanderson Pipe Corp:
  - Main: http://sandersonpipe.com/wp-content/uploads/2019/12/sewer-120519.pdf
  - Service: http://sandersonpipe.com/wp-content/uploads/2019/12/sch40-dwv-120519.pdf http://www.sandersonpipe.com/dimensional_specifications.htm
- Westlake Pipe & Fittings: http://www.northamericanpipe.com/products/water---wastewater https://www.westlakepipe.com/en/product/astm-d3034ib-pvc-gravity-sewer-pipe



HDPE - Gravity Pipe

For use with Force Main Only

(Single Green Stripe to identify DR pipe)
(4 color stipes to identify IPS sized pipe)



(Not for New Construction)

Specification Section: 2530, paragraph 2.1.2. E

Standard Details: N/A

Standard:

- **Mains:** AWWA C906, ASTM D3035, PE 4710 resin, sized and marked in accordance with ASTM F714, IPS, DR17, 8 through 18 inches (must be up-sized 1-inch if diameter is > 12 inches), Gray w/ green strip – gravity sewer only.

Approved Manufacturer/Product	Supplemental Information	Type	Size
☐ CP Chemical/Performance Pipe	Driscoplex 4600 Series	☐ Main	8-inch through 18-inch
☐ JM Eagle	PE Pipe	☐ Main	8-inch through 18-inch
☐		☐ Main	8-inch through 18-inch

LINKS TO MANUFACTURERS:

- CP Chemical/Performance Pipe: https://www.cpchem.com/what-we-do/solutions/performance-pipe/products/municipal/driscoplexr-4600-4700-series-hdpe-sewer
- JM Eagle: http://www.jmeagle.com/watersewer/hdpe-water-sewer-c906-dips

Centrifugally Cast, Fiberglass-Reinforced Polymer Mortar Pipe (CCFRPM)
Direct Bury Installation – Gravity Service
(Diameters 18" to 48")
(when ordered or permitted by the Engineering Director)



Specification Section: 2530, paragraph 2.1.3

Standard Details: N/A

Standards: ASTM D638, ASTM D3262, ASTM D4161, ASTM D2412, and ASTM D3681

Gravity Mains: A dense, nonporous, corrosion-resistant, consistent composite structure Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe. The interior surface of the pipe exposed to sewer flow shall provide crack resistance and abrasion resistance. The exterior surface of the pipes shall be comprised of a sand and resin layer which provides UV protection to the exterior. Pipes shall be Type 1, Liner 2, Grade 3 per ASTM D3262. Diameters 18" to 42"; 20-foot nominal lengths.

Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D4161. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application.

Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.

Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.

Approved Manufacturer/Product

☐ HOBAS

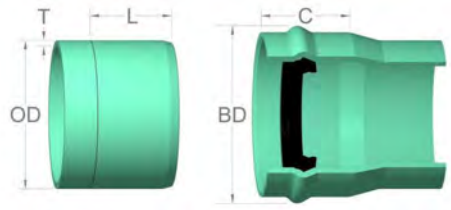
☐

LINKS TO MANUFACTURERS:

- HOBAS: https://www.cpchem.com/what-we-do/solutions/performance-pipe/products/municipal/driscoplexr-4600-4700-series-hdpe-sewer https://hobaspipe.com/products/

PVC/HDPE Pressure Pipe - Force Mains

(Green = Wastewater)



C900
(Green)



C906 HDPE
(1 green stripe)
[to identify DR pipe]

Specification Section: 2530, paragraph 2.1.2. B (C900), D (PVC), and E (HDPE)

Standard Details: N/A

Standard: Mains:
AWWA C900, Pressure Class 150, DR 18 (4-inches – 12 inches), cell classification 12454B;
AWWA C901 and C906 HDPE, DR9, 200 psi;

Approved Manufacturer/Product	Supplemental Information	Type	Size
☐ Diamond Plastic Corporation		☐ Main	4-inch through 12-inch
☐ Performance Pipe		☐ Main	4-inch through 12-inch
☐ Sanderson Pipe Corporation		☐ Main	4-inch through 12-inch
☐ WL Plastics Corp	Formerly Charter Plastics	☐ Main	4-inch through 12-inch

LINKS TO MANUFACTURERS:

- Diamond Plastic Corporation: https://www.dpcpipe.com/docs/CATALOG/DIAMOND%20PLASTICS%20CORP%20CATALOG%20APRIL%202020%20WEB.pdf
- Performance Pipe: http://www.performancepipe.com/en-us/Documents/PP%20524%204000-4100%20Series%20Multi%20Purpose%20Pipe.pdf
- Sanderson Pipe Corp:
  - Mains: (and 4" and greater): https://sandersonpipe.com/wp-content/uploads/2024/06/catalog-2024-C900.pdf
- WL Plastics Corp: https://wlplastics.com/waste-water/ http://www.charterplastics.com/pipe/municipal-and-industrial-pipe

Ductile Iron Pipe – Gravity or Force Main



Specification Section: 2530, paragraph 2.1.1

Standard Details: N/A

Standard: AWWA C104/ANSI21.4, C150/A21.50, C151/A21.51, C111/A21.11, Push-on or Mechanical Joints. Eighteen or twenty-foot standard joint lengths.
Lining: Protecto 401 Ceramic Epoxy or SewperCoat® DIP; ASTM E96
Note: Protecto 401 is not for use as a potable water lining.

Approved Manufacturer/Product	Interior Coating	Class
☐ American Cast Iron Pipe	☐ Protecto 401 Ceramic Epoxy or SewperCoat® DIP	Class 50 or greater
☐ McWane Ductile	☐ Protecto 401 Ceramic Epoxy or SewperCoat® DIP	Class 50 or greater
☐ U.S. Pipe and Foundry Co.	☐ Protecto 401 Ceramic Epoxy or SewperCoat® DIP	Class 50 or greater

LINKS TO MANUFACTURERS:

- American Cast Iron Pipe: https://american-usa.com/products/ductile-iron-pipe-and-fittings/unrestrained-joint-pipe/fastite-joint-pipe
- McWane Ductile: https://mcwaneductile.com/products/ductile-iron-pipe/tyton-join-pipe/
- US Pipe and Foundry Co: https://www.uspipe.com/wp-content/uploads/2020/11/Tyton-2017-v3.pdf

Precast Concrete Manholes



Specification Section: 2530, paragraph 2.2.17

Standard Details: 513.09, 516.01, 532.01, 532.02, 532.03, 532.05, 532.07, 532.09, 532.10, 532.11, 534.02, 534.06

Standard: ASTM C478, Type II Cement, AASHTO M199

Approved Manufacturer/Product

- ☐ Cape Fear Precast
- ☐ Concrete Pipe and Precast (formerly Carolina Precast)
- ☐ Lindsay Precast
- ☐ Mack Industries
- ☐ Old Castle Infrastructure

LINKS TO MANUFACTURERS:

- Cape Fear Precast: (unsafe connection), call for info
- Concrete Pipe and Precast (formerly Carolina Precast): https://www.concretepandp.com/products/sanitary/
  Lindsay Precast: https://www.lindsayprecast.com/sanitary-storm-sewer
- Mack Industries: https://www.mackconcrete.com/precast-concrete-products
- Oldcastle Infrastructure: https://oldcastleinfrastructure.com/product/manholes/

Polymer Concrete Manholes & Grade Rings
(when ordered by the Engineering Director)



Specification Section: 2530, paragraph 2.2.17.B

Standard Details: 513.09, 516.01, 532.01, 532.02, 532.03, 532.05, 532.07, 532.09, 532.10, 532.11, 534.02, 534.06

Standards: ASTM C443, ASTM C478, ASTM C579, ASTM C857, ASTM C923 and C990, ASTM D6783, ACI 440
Manholes: Polymer Concrete Manholes shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness.
Reinforcement: Reinforcement to be acid resistant reinforcement (FRP Bar) in accordance with ACI 40.1R-06 as applicable for polymer concrete design.

Approved Manufacturer/Product	Detail	Size	Other
☐ Armorock		48" Minimum	
☐			

LINKS TO MANUFACTURERS:
- Armorock: https://armorock.com/manholes/

Concrete Grade Rings



Specification Section: 2530

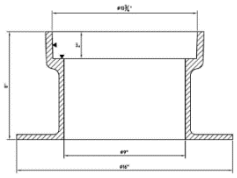
Standard Details: C06.03, 532.10, 532.11,

Standard: ASTM C478, Type II Cement. Thickness: Min. 4/Max. 6" . The top grade ring should be 4"; total height not to exceed 24" from top of casting to first step.

Approved Manufacturer/Product	Thickness
☐ Cape Fear Precast	
☐ Concrete Pipe and Precast (formerly Carolina Precast)	
☐ Lindsay Precast	
☐ Oldcastle Infrastructure	

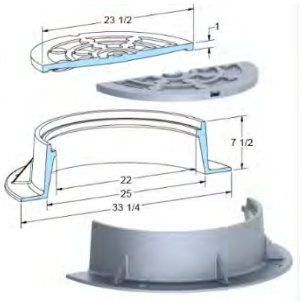
LINKS TO MANUFACTURERS:

- Cape Fear Precast: (unsafe connection), call for info
- Concrete Pipe and Precast (formerly Carolina Precast): https://www.concretepandp.com/products/sanitary/
- Lindsay Precast: https://www.lindsayprecast.com/sanitary-storm-sewer
- Mack Industries: https://www.mackconcrete.com/precast-concrete-products
- Oldcastle Infrastructure: https://oldcastleinfrastructure.com/product/manholes/



Mini-Manhole
(for SS CO in pavement)

Manhole Frame and Cover



Standard MH casting
(at right)

Specification Section: 2530 paragraph 2.2.10

Standard Details: C06.01, C06.02, 516.01, 532.03, 532.07, 532.10, 633.03, 634.01

Standard: ASTM A48, Grade 35B, AASHTO M105 & M 306, uncoated, domestic made, Heavy Duty.
Note: Mini-Manhole covers to have an "S" cast into cover.

Approved Manufacturer/Product	Use	
	Standard	**Watertight**
☐ Capitol Foundry of Virginia, Inc.	☐ -	☐ 2001-WT
	☐ Detail 533.01, Mini-Manhole	☐ VB-9*S
☐ East Jordan Iron Works, Inc.	☐ Sewer: NCDOT compliant Frame: 41384010; Cover: 41384127 ☐ Water: Frame: 41384010; Cover: 41384106 (covers must be embossed with Town's verbiage. See details)	☐ V2384 (Product 42384027W01)
☐ Tricast, Inc.	☐ MH-2001-SS*O (MS2001-ST)	☐ MH-2001-WT*O (MS2001-WT)
	☐ Detail 533.01, Mini-Manhole	☐ MSVB-9-S
☐ US Foundry	669KL	-

LINKS TO MANUFACTURERS/SUPPLIERS:

- Capital Foundry of Virginia, Inc.:
  - Standard Manholes: https://www.capitolfoundry.net/manholes
  - Mini-Manhole (Detail 533.01): https://www.capitolfoundry.net/valve-boxes---cleanouts
- East Jordan Iron Works, Inc.: https://www.ejco.com/am/en/search/?uom=&pagesize=48&pagenum=1&langcode=en_us&productregion=100&sortdirection=desc&defaultsort=score&q=41384010&aId=&an=&firstSearch=false&state= (requires password to enter EJCO portal)
- Tricast, Inc.: https://www.tricastnc.com/products (mini-manhole also available at Consolidated Pipe and Supply Co., Inc., Greenville, NC; T: (252) 754-0700)
- US Foundry: http://www.usfoundry.com/usfoundry-products/catalog/ringsandcovers/productdetails/669

Manhole Boots (pipe-to-manhole connectors)



Specification Section: 2530, paragraph 2.2.17.C

Standard Details: 532.01, 532.03, 532.09, 534.02,

Standard: ASTM C923, double-clamped

Approved Manufacturer/Product	Supplemental Information
☐ A-Lok Products, Inc.	☐ Quik-Lok
☐ NPC, Inc.	☐ Kor-N-Seal® I & II
☐ Press-Seal Gasket Corp	☐ CAST-A-SEAL 12-08

LINKS TO MANUFACTURERS:

- A-Lok Products, Inc.: http://www.a-lok.com/quiklok.html
- NPC, Inc. (Trelleborg): https://www.trelleborg.com/en/seals-and-profiles/products-and-solutions/seals-for-pipes-and-manholes-and-ancillary-equipment/connectors/pipe-to-manhole
  http://www.trelleborg.com/en/pipe-seals/products--and--solutions/connector--sealing--systems
- Press-Seal Gasket Corp: https://www.press-seal.com/product-detail/cast-a-seal-12-08/

Utility Shroud for Sewer Cleanout Assembly (Services in Easements)



Specification Section: 02530

Standard Details: Detail 533.01, sheet 4

Standard:
Pole: **High** Impact PVC, **Cap**: HDPE (available in Cast Iron); **Collar**: HDPE; **Shroud:** HDPE

☐ Utility Defender			

LINKS TO MANUFACTURERS:
Utility Defender: https://www.utilitydefender.com/

Sewer Connection to Existing Sewer Mains (Repair Coupling)

(Main Line Repair Coupling Used on existing sewer mains when inserting an In-Line Wye)



Specification Section: 2530 Paragraph 2.2.19

Standard Details: Detail 533.01; Detail 533.02

Standard:
ASTM C1173, UPC 4224, Corrosion Resistant AISI 304 Series Stainless Steel Click-Lock Clamping System, High Impact Polyamide (Nylon) Securing Cage, Injection Molded EPDM Rubber Sealing Gasket

Approved Manufacturer/Product	Size	Type of Pipe	Part/Catalog#	**L** (inches)
☐ Gripper Gasket, LLC / MAXADAPTOR	☐ 8”	Varies	MAX8	14.96
	☐ 10”	Varies	MAX10	18.504
	☐ 12”	Varies	MAX12	21.654
	☐ 15”	Varies	MAX16	27.563

LINKS TO MANUFACTURERS:

- Gripper Gasket, LLC: https://maxadaptor.com/

Sewer Tap Saddle



Specification Section: 2530 paragraph 2.1.2.F

Standard Details: 533.02

Standard: Elastomeric Flexible Saddle with Sch 40 inlet and Type 300 Stainless Steel clamps,

Approved Manufacturer/Product	Model	Sizes
☐ NDS (elastomeric)	☐ 4Y-C	4 -inch branch outlets
☐ MIFAB (flexible PVC)	☐ MI-SEW-W4	4 -inch branch outlet

LINKS TO MANUFACTURERS:

- NDS: https://www.ndspro.com/PDFs/Tech-Spec-Sheets/Flexible-Saddle.pdf
- MIFAB: https://www.mifab.com/Catalog/Library/MI-SEW.pdf

Butyl Rubber Sealant



Specification Section(s): 2530 paragraph 2.2.17

Standard Details: 513.09, 516.01, 532.03, 532.05, 532.07, 534.02, 534.06

Standard: FS SS-S-00210 (210-A), ASTM C990, Type 1, Rope Form, ¾" diameter (min.)

Approved Manufacturer/Product	Supplemental Information
☐ ConSeal Concrete Sealants, Inc.	☐ CS-102 (only)
☐ Henry Company, Sealants Division	☐ RN101 – Ram-Nek Joint Sealant (Strips) ☐ RN103 – Ram-Nek Joint Sealant (Coils)

LINKS TO MANUFACTURERS:

- ConSeal Concrete Sealants, Inc.: https://conseal.com/products/cs-102-butyl-rubber-sealant/
- Henry Company, Sealants Division.:
  - RN101: https://henry.com/performance-additives/concrete-joint-sealants/rn101-ram-nek-preformed-flexible-gasket-strips
  - RN103: https://henry.com/performance-additives/concrete-joint-sealants/rn103-ram-nek-preformed-flexible-plastic-gasket-coils

Bore and Jack Operations

Specification Section: 2510, paragraph 2.1.5; 2530 paragraph 2.1.4

Standard Details: C07.01, C07.02

Standard:

Casing Pipe: ASTM A139, grade B steel pipe casing, 35,000 psi minimum yield/60,000 psi minimum tensile, ASTM A283, uncoated

Casing Spacers/Insulators: Spacers used to support and center carrier pipe and to insulate/catholically protect a pipe line from a casing pipe through which it must pass.

Band to be minimum 14-gauge, T-304 Stainless Steel with a minimum 10 ga T-304 Stainless Steel riser and T-304 SS bolts, washers, and nuts. Liner on band to be EPDM.

Runners/Risers to be 1" or 2" wide glass filled polymer plastic; band lengths minimum 7" up to 12". All risers to be welded to the band by MIG welding. Unless otherwise noted on plans or specified, band is to have 4 equal legs for carrier pipe 16" and under; 5 legs for carrier pipe 18" to 24" and 6 legs for pipe 30" to 42". Stainless steel welds are fully passivated to prevent corrosion.

End Seals: 1/8" thick synthetic rubber seamless pull-on end seals with stainless steel bands.

Approved Vendors	Casing Spacers/Spiders	End Seals
☐ Advance Products and Systems	☐ SSI	☐ Model AC Pull-On End Seal;
☐ Spider Manufacturing, Durham, NC	☐ Black Widow Casing Spacers	
Steel Pipe		
☐ Southland Pipe Corporation	☐	
☐ Spiralco, Inc.	☐	

LINKS TO MANUFACTURERS:

Casing Spacers, End Seals:

- Advance Products and Systems: https://apsonline.com/casing-spacers/
- Spider Manufacturing: http://www.spiderpipesupports.com/polymerskids.htm
- https://spiderpipesupports.com/products/black-widow-casing-spacers-spider-manufacturing/

Pipe:

- Southland Pipe Corporation: http://www.southlandpipe.com/products.htm#sthash.cLJmiMZv.dpbs
- Spiralco, Inc.: http://www.spiralco.com/English/Produits/Produits.htm



Wastewater Combination
Air Release/Vacuum Valves
(A.R.I. at left; Vent-Tech at right)

(No iron body air valves in sewer system)



Specification Section: 2530, paragraph 2.2.4

Standard Details: 534.06

Standard:
Valve Body:
NPT Inlet Body, minimum working pressure 3 - 145 psi;
Reinforced Nylon/Stainless Steel (SAE 316) Body and Flange (A.R.I).,
Cylindrical Body, ASTM A240 SAE 304L or 316L Stainless Construction (Vent-Tech)

Manufacturer & Product – Stainless Steel	Model
☐ A.R.I. USA, Inc.	☐ D-025 ST / D-025 STST (stainless steel models)
☐ Vent-Tech Vacuum/Air Relief Valve	☐ Model SWG (Model SDG or equal for low clearance)

LINKS TO MANUFACTURERS:

- A.R.I.: https://www.ariusa.com/products/wastewater/item/d-025-combination-air-valve-for-wastewater-short-version
- Vent-Tech: https://www.flotechinc.com/products/vent-tech-model-swg-combination-air-release-valve/

Manhole Flexible Exterior Joint Sealant



Specification Section: 2530, paragraph 2.2.13

Standard Details: 532.03, 532.05, 532.07, 532.10, 534.02

Standard: EPDM Rubber, minimum 30 mils, 12" wide, stretchable, self-shrinking, ASTM C877 Type III, C923

Manufacturer & Product	Model
☐ Conseal Concrete Sealants, Inc.	CS-212 Polyolefin Backed Exterior Joint Wrap
☐ Sealing Systems, Inc.	Infi-Shield External Gator Wrap

LINKS TO MANUFACTURERS:

- Conseal Concrete Sealants, Inc.: https://conseal.com/products/cs-212-polyolefin-backed-exterior-joint-wrap/
- Sealing Systems, Inc.: http://www.ssisealingsystems.com/gator_wrap_band_install.html https://www.ssisealingsystems.com/gator-wrap.html

Aluminum Hatches

Specification Section: 02530 paragraph 2.2.22

Standard Details: 534.02

Standard: Non-traffic rate aluminum hatches, one-piece aluminum extruded frame with a continuous concrete anchor as part of the one-piece extrusion. Door panels are to have ¼-inch thick aluminum diamond plates to withstand a live load of 300 psf with a 1.5 safety factor. Doors to be provided with SS hinges with tamper-proof fasteners. All hardware is to be stainless steel. Hatch doors to be spring-loaded. Doors to open 90 degrees and lock automatically in that position with a stainless steel positive locking arm and a SS release handle. Door to have padlock hasp for doors on wet wells and valve vaults. Doors to close flush with top of frame. Hatches to be equipped with fall protection grating system features meeting OSHA fall protection standards.

Manufacturer & Product	Valve Vault (36"x36" Min)	Wetwell
☐ The Bilco Company	☐ J-4AL	☐ JD-2AL (4'x4' min)
☐ Halliday Products, Inc.	☐ S1R	☐ W2S4848 min
☐ US Foundry & Manufacturing Corp.	☐ APS 36x36 w/OP	☐ THD 48x48 w/OP min

LINKS TO MANUFACTURERS:

- Bilco: https://www.bilco.com/ProductDetail/Type-J-AL-Channel-Frame-300-PSF-41
- Halliday Products, Inc.: http://www.hallidayproducts.com/accesscovers.html
- US Foundry & Manufacturing Corp.: https://www.usffab.com/our-products/aluminum-floor-access-doors/



In-Line Transition Coupling

(see also Repair Coupling)



Specification Section: 2530, paragraph 2.2.19

Standard Details: -

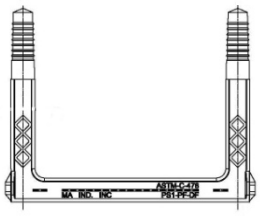
Standard: Wide range cast coupling to join plain end pipe of all outside diameters within the coupling range. Meets applicable AWWA C219 Standards. Sleeve to be Heavy cast Ductile Iron meeting ASTM A536 with fusion-bonded epoxy finish. Gaskets to be Nitrile (Buna N) NSF 61 approved. Stainless settle nuts and bolts to meet ANSI A21.11 (AWWA C111). Neither Fernco Couplings nor poured concrete collars are permitted.

Manufacturer	Product
☐ **Hymax** (Mueller Brand)	☐ Hymax 2 Wide Range Coupling
☐ **Romac Industries**	☐ XR 501
☐ **Smith Blair (Xylem)**	☐ 461

LINKS TO MANUFACTURERS:

- Hymax (Mueller Brand): https://www.hymaxusa.com/products-main/hymax-2
- Romac Industries (Transition & Reducing Couplings): https://romac.com/xr501
- Smith-Blair: https://www.xylem.com/en-us/brands/smith-blair/smith-blair-products/461-quantum-coupling/

Manhole Steps



Specification Section: 2530, paragraph 2.2.18.E

Standard Details: C06.04, 532.03, 532.07, 534.02

Standard: ASTM C478 and D4101, ASTM A615, and AASHTO M-199.
Copolymer polypropylene plastic with embedded ½" diameter ASTM A615 Grade 60 steel reinforcement.

Manufacturer & Product	Model	Reinforcement
☐ M. A. Industries, Inc.	PS1-PF	½" dia. grade 60 rebar
☐		

LINKS TO MANUFACTURERS:

- M. A. Industries, Inc.: https://precast-supplies.com/products/ps1-pf-sf

SUBMERSIBLE PUMPS & FORCE MAINS

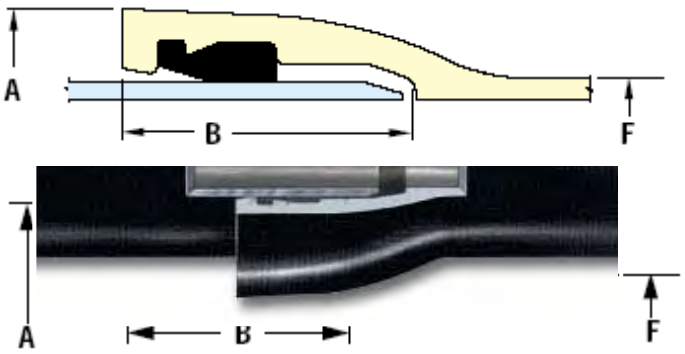
Pumps, Pump Station	
Specification Section: 2530, paragraph 3.10	
Standard Details: 534.02	
Standard:	
Approved Manufacturer/Product	**Model**
☐ Fairbanks Nijhuis	☐
☐ Sulzer ABS	☐

LINKS TO MANUFACTURERS:

- Fairbanks Nijhuis (formerly Fairbanks-Morse): https://www.pentair.com/en-us/brands/fairbanks-nijhuis.html
- Sulzer ABS: http://www.grpumps.com/pumptype/product/Self-Priming-Pumps https://www.sulzer.com/en/shared/services/original-spare-parts-type-abs

Water Distribution
PRE-APPROVED MATERIAL/PRODUCT LIST
Town of Clayton

Ductile Iron Pipe Mains / Push-On Joint



Specification Section: 2510, paragraph 2.1.2

Standard Details: N/A

Standard: AWWA C104, C111, C151, NSF/ANSI 61, NSF/ANSI 372 certified lead free. Eighteen or twenty-foot standard joint lengths.

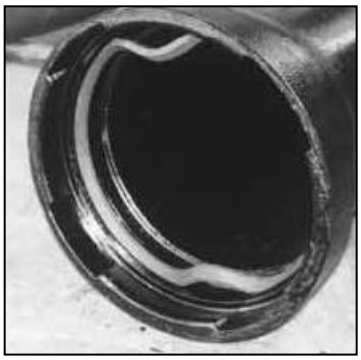
Approved Manufacturer/Product	Size	Pressure Class
☐ American Cast Iron Pipe	6-inch to 48-inch	350
☐ McWane Ductile	6-inch to 48-inch	350
☐ U.S. Pipe and Foundry Co.	6-inch to 48-inch	350

LINKS TO MANUFACTURERS:

- American Cast Iron Pipe: http://www.american-usa.com/products
- McWane: http://mcwaneductile.com/resources/specifications
- US Pipe and Foundry Co: https://www.uspipe.com/ductile-iron-pipe/

Ductile Iron Pipe Mains / TR FLEX Restrained Push-On Joint Pipe





Specification Section: 2510, paragraph 2.1.2.A.3

Standard Details: N/A

Standard: Ductile Iron locking segments, inserted through a slot (or slots) in the bell face, to provide a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe; used with standard size Tyton gasket. AWWA C104/A21.4, C111/A21.11, C150/A21.50, C151/A21.51, NSF/ANSI 61, NSF/ANSI 372 certified lead free. Eighteen or twenty-foot standard joint lengths.
For Sanitary Sewer Applications:
AWWA C151/A21.51 exterior coating, Protecto 401 Ceramic Epoxy Lining, pipe thickness class 50

Approved Manufacturer/Product	Size	Pressure Class	Joint Type
☐ American Cast Iron Pipe	6-inch to 36-inch	350-psi	Lok-Ring or Flex-Ring Restrained Push-On Joints
☐ McWane, Inc.	6-inch to 36-inch	350-psi	TR FLEX Restrained Push-On Joints
☐ Griffin Pipe (U.S. Pipe and Foundry Co.)	6-inch to 36-inch	350-psi	Snap-Lok Restrained Push-On Joints
☐ U.S. Pipe and Foundry Co	6-inch to 36-inch	350-psi	TR Flex Restrained Push On Joints

LINKS TO MANUFACTURERS:

- American Cast Iron Pipe:
  - Flex-Ring: http://www.american-usa.com/products/ductile-iron-pipe-and-fittings/restrained-joint-pipe/flex-ring-joint-pipe
  - Lok-Ring: https://american-usa.com/products/ductile-iron-pipe-and-fittings/restrained-joint-pipe/lok-ring-joint-pipe
- McWane, Inc.: https://mcwaneductile.com/products/ductile-iron-pipe/tr-flex-restrained-joint-pipe/
- US Pipe and Foundry Co: https://www.uspipe.com/ductile-iron-pipe/tr-flex-restrained-joint-pipe/

Ductile Iron Fittings
Mechanical Joint





Specification Section: 2510, paragraph 2.1.2B

Standard Details: N/A

Standard: AWWA C110 (Full Body Fittings), C153 (Compact Fittings), NSF/ANSI 61, NSF/ANSI 372 certified lead free

For Sanitary Sewer Applications:

AWWA C151/A21.51 exterior coating, Protecto 401 Ceramic Epoxy Lining, pipe thickness class 50

Approved Manufacturer/Product	Size	Pressure Class	Joint Type
☐ American Cast Iron Pipe	6-inch to 48-inch	350-psi	MJ
☐ McWane Ductile	6-inch to 48-inch	350-psi	MJ
☐ Star Pipe Products	6-inch to 48-inch	350-psi	MJ
☐ U.S. Pipe and Foundry Co.	6-inch to 48-inch	350-psi	MJ

LINKS TO MANUFACTURERS:

- American Cast Iron Pipe: https://american-usa.com/products/ductile-iron-pipe-and-fittings/fittings
- McWane Ductile: https://www.mcwaneductile.com/products/fittings-and-accessories/
- Star Pipe Products: http://www.starpipeproducts.com/utilities.asp
- US Pipe and Foundry Co: https://www.uspipe.com/wp-content/uploads/2020/12/20119161010380.Mech-Joint-Fittings-BRO-007.pdf

PVC Pipe – Water
(Blue = Water)



Specification Section: 2510, paragraph 2.1.3

Standard Details: N/A

Standard: AWWA C900, ASTM D3139, ASTM F477, ASTM D1784, NSF 61, Pipe shall bear seal of NSF for potable water pipe. C900 to be used with ductile iron fittings (restrained joint). C900 fusible PVC for direction boring shall only be used with written permission of Engineering Director.

Approved Manufacturer/Product	Type	Size
☐ Diamond Plastics Corp	Min Press Class 150, DR18	6-inch through 12-inch
☐ JM Eagle	Min Press Class 150, DR18	6-inch through 12-inch
☐ National Pipe	Min Press Class 150, DR18	6-inch through 12-inch
☐ North America	Min Press Class 150, DR18	6-inch through 12-inch
☐ Sanderson Pipe Corporation	Min Press Class 150, DR18	6-inch through 12-inch

LINKS TO MANUFACTURERS:

- Diamond Plastic Corporation: https://www.dpcpipe.com/c900.php
- JM Eagle: http://www.jmeagle.com/products/waterworks/blue-brute.html
- National Pipe: http://www.nationalpipe.com/printable/Dura%20Blue%20C900.pdf
- North America: https://www.napcopipe.com/en/product/pipe/awwa-c900ib-pvc-pressure-pipe
- Sanderson Pipe Corp: http://sandersonpipe.com/wp-content/uploads/2019/12/c900-121619.pdf

HDPE Pipe for Directional Boring Applications – Water



Specification Section: 2510, paragraph 2.1.4

Standard Details: N/A

Standard: AWWA C901 & C906, DR9, 200-psi, NSF approved. ASTM D3350 Cell Class 445574C/E, All HDPE pipe shall be one size larger than connected pipe (i.e., 8 inch PVC to 10 inch HDPE)

Approved Manufacturer/Product		**Size**
☐ J.M. Eagle		6-inch through 16-inch
☐ Performance Pipe (formerly Plexco & Driscopipe)	Driscoplex 4000	6-inch through 16-inch
☐		

LINKS TO MANUFACTURERS:

- JM Eagle: http://www.jmeagle.com/sites/default/files/JM%20Eagle%20HDPE%20WaterSewer%20C906%20DIPS.pdf
- Performance Pipe: https://www.cpchem.com/sites/default/files/2022-03/PP%20501%20Driscoplex%204000%204100%20Water%20Pipe%20Brochure.pdf

Valves





Specification Section: 2510, paragraphs 2.2.4, 2.2.6

Standard Details: 513.02, 513.03, 513.09, 514.01, 514.04, and 514.05

Standard:
Gate Valves: AWWA C509; 2”-12” Resilient seat, open left, Mechanical Joint; AWWA C515 (flanged); 16” and Larger, MJ;
Butterfly Valves: AWWA C504 , open left, with indicator, Mechanical Joint, NSF/ANSI 61, NSF/ANSI 372 certified lead free. (Class 150B). All exposed nuts/bolts must be stainless steel on all valves.

Approved Manufacturer/Product	**Gate Valves**	**Tapping Valves**	**Butterfly Valves** (min class 150B)
☐ American Flow Control	☐ 2500SS Series	☐ 2500 TM	☐
☐ DeZurik	☐	☐	☐ M-Series Manual Actuator
☐ Kennedy	☐ RWGV 8571 (2”-12”) ☐ RWGV 7571 (16”-24”) ☐ KS-RW (30”-54”)	☐ RWGV 8571 (2”-12”) ☐ RWGV 7571 (16”-24”) ☐ KS-RW (30”-54”)	☐
☐ McWane Ductile (formerly Clow Valve Company)	☐ F-6100/OR	☐ F-6114	☐ 4500-01 (200-psi)
☐ Mueller Company	☐ A-2360-20	☐ T-2360	☐ Lineseal III (200-psi)

LINKS TO MANUFACTURERS:

- American Flow Control: https://american-usa.com/products/valves-and-hydrants/2-12-series-2500-resilient-wedge-gate-valves/2-12-resilient-wedge-gate-valves-with-mechanical-joint-ends
- DeZurick: https://api.ferguson.com/dar-step-service/Query?ASSET_ID=4829472&USE_TYPE=SPECIFICATION&PRODUCT_ID=2491323
- Kennedy:
  - 2”-12 (AWWA C509)”: https://pe.mcwane.com/groups/valve-hydrant/kennedy-valve/product/007e82d6-929c-11e3-a34a-0026b958ebf1
  - 16”-24” (AWWA C515): https://pe.mcwane.com/upl/downloads/catalog/products/ks-rw-product-brochure-c515.pdf
  - 30”-54” (AWWAC515): https://pe.mcwane.com/upl/downloads/catalog/products/product-brochure-c515-14-54-geared-rwgv.pdf https://pe.mcwane.com/groups/valve-hydrant/kennedy-valve/product/007db4c8-929c-11e3-a34a-0026b958ebf1
- McWane Ductile: http://www.clowvalve.com/upl/downloads/resources/product-brochures/c509-2-12.pdf
- Mueller Company: http://www.muellercompany.com/files/Water%20Section%2010.pdf

Valves, SS ¼-Turn Ball



Specification Section: 2510, paragraph 2.2.3

Standard Details: 516.01

Standard: 2-inch and smaller (only allowed on ARV's), FNPT X FNPT, 200-psi minimum (non-shock cold water rated), NSF/ANSI 61 and 372 certified lead free

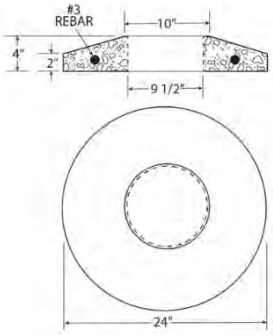
Approved Manufacturer/Product	Ball Valves		
☐ Apollo	☐ 76-100		
☐ Watts	☐ S-FBV-1		

LINKS TO MANUFACTURERS/SUPPLIERS

- Apollo; https://www.mscdirect.com/product/details/37011558
- Watts: https://www.watts.com/products/plumbing-flow-control-solutions/shutoff-valves/ball-valves/s-fbv-1 http://www.watts.com/pages/_products_details.asp?pid=566



Round Valve Box Pad
(in unpaved areas only)



Specification Section: N/A

Standard Details: 513.03

Standard: 4" tall 24" diameter valve box pad (pad is 4" in depth with a taper down to 2" at the outside edge). Pad to be made of concrete (Type I cement) and reinforced using #3 rebar (available upon request). The top of the pad has a hole with a diameter of 10" and the hole is tapered through the pad giving it a final bottom diameter of 9 1/2". Weight approximately 80 lbs.

Approved Manufacturer/Product	Model	Diameter	Depth
☐ Southern Meter Box, Inc.	☐ Round Valve Box Pad	24 inches	4 inches
☐ Southern Pipe & Supply	☐ HRVP24 (Sigma Corp)	24 inches	4 inches

LINKS TO MANUFACTURERS/SUPPLIERS

- Southern Meter Box: http://www.southernmeterbox.com/content/round-valve-box-pad http://www.watts.com/pages/_products_details.asp?pid=566
- Southern Pipe & Supply: https://www.southernpipe.com/2309234/Product/Sigma_Corporation_HRVP24



Fire Hydrants

Hydrant Elbow with Mueller AquaGrip® System (Left)
(Connection and Restraint)



Specification Section: 2510, paragraph 2.2.8

Standard Details: 514.04, 514.05, 514.06

Standard: AWWA C502, UL 246, FM 1510, AWWA C550, 6" MJ inlet, 5-1/4" foot valve, (1) 4 ½-inch steamer nozzle with auxiliary straight pattern Storz Fire Department Connection , (2) 2 ½-inch nozzles with N.S. threads, 1 ½" open counter clockwise (left) pentagonal operating nut, NSF/ANSI 61, NSF/ANSI 372 certified lead free, Public hydrants painted Federal Safety Red (barrel & bonnet).

Hydrant Elbow w/ Mueller AquaGrip System: Fire Hydrants are to include the Mueller AquaGrip® System connection and restraint at the hydrant/valve bell. The AquaGrip® System connecting to hydrant elbow is to be compatible with ductile iron pipe, both C900 and C909 PVC pipe, UL listed, FM approved, and NSF/ANSI 61, NSF/ANSI 372 certified lead free. The AquaGrip® System is to meet the performance requirements of ASTM F1674 and ISO 14236-2. Fitting to be of Ductile Iron construction with fusion bonded epoxy coating and shall include fully assembled stab connection with break-away nuts, gripper ring, and a pressure responsive double O-ring. Maximum working pressure up to 250 psi.

Approved Manufacturer/Product	Model	Dewatering	Bury depth
☐ American Darling	B-62-B		3-foot or 4-foot
☐ American Darling (American Flow Control	B-84-B		3-foot or 4-foot
☐ M&H	Style 129		3-foot or 4-foot
☐ McWane Ductile (formerly Clow Valve Company)	F-2545 Medallion		3-foot or 4-foot
☐ Mueller Company	A-423 Super Centurion 250		3-foot or 4-foot

LINKS TO MANUFACTURERS:

- American Darling: https://american-usa.com/products/valves-and-hydrants/fire-hydrants/5-1-4-american-darling-b-62-b-5
- American Darling w/ AquaGrip System Bases: https://american-usa.com/products/valves-and-hydrants/fire-hydrants/american-fire-hydrants-with-alpha-base
- American Flow Control: https://american-usa.com/products/valves-and-hydrants/fire-hydrants
- M & H Valve Co.: https://www.mh-valve.com/products/hydrants/5-1-4in-mvo-129-3-way-model-129/
- McWane Ductile: https://www.clowvalve.com/upl/downloads/catalog/products/product-brochure-medallion.pdf
- Mueller Company: https://www.muellercompany.com/fire-protection/ulfm-hydrants/super-centurionr/

Brass Pipe and Fittings





Specification Section: 2510, paragraph 2.1.1.B

Standard Details: 514.01, 516.01 , 519.01, 519.03, 519.07

Standard: ASTM B43, AWWA C800, Regular Strength, NPT, Sch 40 minimum, NSF/ANSI 61, NSF/ANSI 372 certified lead free

Approved Manufacturer/Product	Supplemental Information
☐ Merit Brass	
☐ .	

LINKS TO MANUFACTURERS:

- Merit Brass: http://www.meritbrass.com/Dimensions/BrassPipe.pdf

Automatic Flushing Device



Model #9400





Model #9800

Specification Section: 2510, paragraphs 2.2.11 and 3.3.4

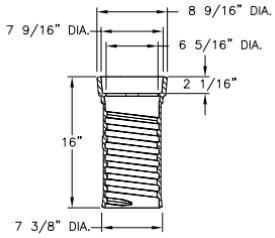
Standard Details: -

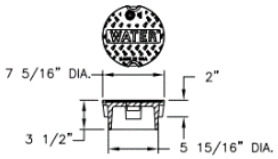
Standard: Permanent automatic flushing station for cold climates. Adjustable 2" solenoid-operated valve with a 200 gpm maximum flushing capacity and a pressure rating of 220 psi. Diaphragm valve opens and closes slowly to avoid water hammer issues. Station features a UV-resistant lockable enclosure. Fully maintainable above grade – no digging required.
Model #9400 Discharges to grade onto a diffusion plate.
Model #9800 Flushes below grade directly into a sanitary/storm sewer, drainage ditch, etc. Sampling point bibb comes standard with flushing unit housed inside a lockable UV resistant enclosure.

Approved Manufacturer/Product	Model	Bury depth	Size
☐ The Kupferle Foundry Company	☐ Eclipse #9400 (discharges to grade)	36" for 12" or less 42" for 16" and larger	2-inch
	☐ Eclipse #9800 (discharges below grade)	36" for 12" or less 42" for 16" and larger	2-inch

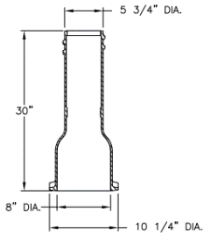
LINKS TO MANUFACTURER:

- The Kupferle Foundry Company:
  - Model #9400: https://hydrants.com/product/eclipse-9400/#
  - Model #9800: https://hydrants.com/product/eclipse-9800/





Valve Boxes



Specification Section: 02510, paragraph 2.2.7

Standard Details: 513.01

Standard: Gray Iron, Screw Type, 5 ¼" shaft, ASTM A48, Grade 35B, AASHTO M306, Heavy Duty, Bituminous coating; slide or slip type is NOT acceptable.

Approved Manufacturer/Product	Number
☐ Bingham & Taylor	15B CI Screw Type Valve Box, marked "Water"
☐ East Jordan	8550 6800 set (Range 27-37 inches)-Product No. 85502737
☐ Southern Foundry	562A

LINKS TO MANUFACTURERS:

- Bingham & Taylor: https://bandt-us.com/products/valveboxes/
- East Jordan.: https://www.ejco.com/am/en/product/details?productid=3074457345617105333 (requires password to log in)
- Southern Foundry: No website

Stainless Steel Tapping Sleeve



Specification Section: 2510, paragraph 2.2.7

Standard Details: 513.02

Standard: AWWA C223, 18-8 type 304 Stainless Steel MJ, 150 psi minimum working pressure, the sleeve and gasket shall provide full wrap-around (360 degree) pipe coverage, MJ Outlet. NSF/ANSI 61, NSF/ANSI 372 certified lead free

Approved Manufacturer/Product	Number	Sizes
☐ Mueller	H-304SS	4-inch through 12-inch
☐ Romac Industries, Inc.	Style SST w/ stainless steel flange	4-inch through 12-inch
☐ Smith-Blair (Xylem)	Model #665	4-inch through 12-inch

LINKS TO MANUFACTURERS/SUPPLIERS:

- Mueller: https://www.muellercompany.com/fire-protection/tapping-materials/h-304-stainless-steel-tapping-sleeve/
- Romac Industries, Inc.: http://www.romac.com/tappingsleeves/sst.html
- Smith-Blair: **Error! Hyperlink reference not valid.**https://www.xylem.com/en-us/products--services/pipe-fittings/tapping-sleeves/665-tapping-sleeve/



(3/4” to 2”)

Backflow Preventers
RPZ Assemblies



(3” to 10”)

Specification Section: 2510, paragraph 2.2.2.C, D

Standard Details: 519.07, 519.08, 519.09, 519.10, 519.11

Standard:

Reduced Pressure Principle Assembly w/ Union Ball Valves (¾” to 2” RPZ): ASSE® Listed 1013, CSA® Certified, AWWA compliant C511, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, Meets the requirements of NSF/ANSI/CAN 61. Low Lead Cast Bronze ASTM B 584 Main valve body & Access covers, Stainless Steel, 300 Series fasteners, and Silicone (FDA Approved) Buna Nitrile (FDA Approved) elastomers and Noryl™ polymers.

Reduced Pressure Principle Assembly BFP (3” to 10” RPZ): The Reduced Pressure Zone Assembly shall consist of two independent torsion spring check modules, a differential pressure relief valve located between and below the two modules, two drip tight shutoff valves, and required torsion spring check modules and bottom mounted relief valve shall be contained with a sleeve accessible single housing constructed from 304 (Schedule 40) stainless steel pipe with groove end connections. Connecting OS&Y FxG/GxF gate valves. Maximum working Pressure: 175 psi.

Housing & Sleeve: 304 (Schedule 40) Stainless Steel.

Elastomers: EPDM, Silicone and Buna-N

Approvals: AWWA C511 Compliant, ASSE® Listed 1013, FM Approved, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California. Meets the requirements of NSF/ANSI/CAN 61 certified lead free.

OS&Y Gate Valves - FxG/GxF: Resilient seat gate valves shall comply with AWWA C515-09.· Body, bonnet, and wedge made of high strength ductile iron per ASTM A536 65-45-12.· Interior and exterior of the valves are fusion bond epoxy coated per AWWA C550. Epoxy powder is certified to NSF-61.

Approved Manufacturer/Product	Number	Sizes
☐ Watts	957OSY (RPZ)	3-inch through 10-inch
☐ Zurn-Wilkins	975XL2U (RPZ)	3/4-inch through 2-inch
☐		

LINKS TO MANUFACTURERS/SUPPLIERS:

- Watts RPZ (3” to 10”): https://www.watts.com/dfsmedia/0533dbba17714b1ab581ab07a4cbb521/20280-source/es-957-957n-957z-pdf
- Zurn Wilkins (¾” to 2” RPZ): https://www.zurn.com/media-library/web_documents/pdfs/specsheets/bf-975xl2u-pdf
  https://www.zurn.com/products/water-control/backflow-preventers/375da



(3/4" to 2")

Backflow Preventers
DCV Assemblies



(3" to 10")

Specification Section: 2510, paragraph 2.2.2.A, B

Standard Details: 519.06, 519.07, 519.08, 519.09, 519.10, 519.11

Standard:

Double Check Detector Assemblies (Sizes ¾" to 2"): ASSE® Listed 1015, CSA® Certified, AWWA compliant C510, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, Meets the requirements of NSF/ANSI/CAN 61. Low Lead Cast Bronze ASTM B 584 Main valve body & Access covers, Stainless Steel, 300 Series springs, and Silicone (FDA Approved) Buna Nitrile (FDA Approved) elastomers and Noryl™ polymers. Maximum working water pressure 175 PSI.

Double Check Detector Assemblies (Sizes 3" to 10", OS&Y only) – Fire Protection Only: All internal metal parts: 300 Series stainless steel, Main valve body: 300 Series stainless steel, Check assembly: Noryl® Flange dimension in accordance with AWWA Class D.

The bypass line shall be hydraulically sized to accurately measure low flow. The bypass line shall consist of a meter, a small diameter double check assembly with test cocks and isolation valves. The bypass line double check valve shall have two independently operating modular poppet check valves, and top mounted test cocks.

The integrated supervisory tamper switch on the OSY model shall have continuity with the valve fully open and activate within two (2) turns from open. The device consists of two SPDT switches and is designed to send a tamper signal when the valve is closed and when the switch is removed from the valve. In the neutral position, the switch indicates the valve is fully open.

Housing & Sleeve: 300 Series Stainless Steel.

Elastomers: EPDM, Silicone, and Buna-N elastomers, Noryl™ polymers.

Approvals: ASSE® Listed 1048, AWWA compliant C510, UL 1469, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, DOES NOT Meet the requirements of NSF/ANSI/CAN 61.

OS&Y FxF Gate Valves: Resilient seat gate valves shall comply with AWWA C515-09.· Body, bonnet, and wedge made of high strength ductile iron per ASTM A536 65-45-12.· Interior and exterior of the valves are fusion bond epoxy coated per AWWA C550. Epoxy powder is certified to NSF-61. Maximum working Pressure: 175 psi.

Approved Manufacturer/Product	Number	
☐ Ames	3000SS for **Fire Protection ONLY** (not permitted for drinking/dishwashing)	3-inch through 10-inch
☐ Zurn-Wilkins	950XL Domestic	3/4-inch through 2-inch
☐		

LINKS TO MANUFACTURERS/SUPPLIERS:

- Ames (a Watts brand): (3" to 10"): https://www.watts.com/products/plumbing-flow-control-solutions/backflow-preventers/double-check-detector-assemblies/3000ss
- Zurn Wilkins (¾" to 2" RPZ): https://www.zurn.com/media-library/web_documents/pdfs/specsheets/bf-950xl-pdf https://www.zurn.com/products/water-control/backflow-preventers/375da

Copper Tubing



Specification Section: 2510, paragraph 2.1.1.A

Standard Details: 513.04, 519.01, 519.02, 519.03

Standard: Seamless, Type K, Soft, ASTM B88, NSF/ANSI 61, NSF/ANSI 372 certified lead free. No joints allowed between main and meter box.

Approved Manufacturer/Product	Sizes
☐ Mueller Industries	¾-inch to 2-inch

LINKS TO MANUFACTURERS:

- Mueller: https://muellerstreamline.com/?wpdmdl=496

Corporation Stop



Specification Section: 2510, paragraph 2.2.10

Standard Details: 513.04, 519.04

Standard: AWWA C800, NSF/ANSI 61, NSF/ANSI 372 certified lead free, Ball Valve, 300 psi working pressure, CC tapered threaded inlet by compression copper outlet. All services require a double strap bronze saddle. 2-inch corporation stops are not permitted.

Approved Manufacturer/Product	Model Number	Sizes
☐ AY McDonald	☐ 74701BG	3/4" through 1-inch
☐ The Ford Meter Box Co.	☐ FB1000-3-G-NL ☐ FB1000-4-G-NL	¾-inch 1-inch
☐ Mueller	☐ B-25008N	¾" through 1-inch

LINKS TO MANUFACTURERS:

- AY McDonald: https://www.aymcdonald.com/en/product/water-works-corporation-stops-corp-stops-awwa-ball-style/74701bg-1-14-ball-corp-awwa-x-cts-nl--5142-324
- The Ford Meter Box Company: https://www.fordmeterbox.com/products/item/fb1000-4-g-nl
- Mueller: https://www.muellercompany.com/water-works/service-brass/corporation-valves/ball/b-25008n/



5/8" X ¾", 1-inch Meter Setters
2-inch Meter Setter



Specification Section: 2510 paragraph 2.3.12.A, B

Standard Details: 519.01

Standard: AWWA C800, (ASTM B62 and ASTM B584, UNS NO C83600 - 85-5-5-5 Brass), NSF/ANSI 61, NSF/ANSI 372 certified lead free

Approved Manufacturer/Product	Number	Size
☐ Cambridge Manufacturing	☐ #6020212H3H3UQ-NL ☐ #6020412H4H4UQ-NL	5/8" X ¾" 1-inch
☐ The Ford Meter Box Co.	☐ VBHC72-12W-44-33-G-NL ☐ VBHH72-12W-44-33-G-NL ☐ VBHC74-12W-44-44-G-NL ☐ VBHH77-18BHC-11-77-NL	5/8" X ¾" 1-inch 2-inch
☐ Mueller	☐ B-2470-2A-NL (12" Height) ☐ H-1423-2 (must specify 2-in. meter w/ 18" rise)	5/8" X ¾", 1-inch 2-inch

LINKS TO MANUFACTURERS:

- Cambridge Brass: https://www.cambridgebrass.com/page.php?id=15
- The Ford Meter Box Company:
  5/8"x3/4", 1-inch: http://www.fordmeterbox.com/submittals/VBH76-xx-11-66-NL.pdf
  https://www.fordmeterbox.com/products/item/VBHH72-12W-44-33-G-NL?upload=true
  2-inch setter: https://www.fordmeterbox.com/products/item/vbhh77-18bhc-11-77-nl
  - Mueller: 5/8" x ¾", 1-inch & 2-inch: https://www.muellercompany.com/water-works/service-brass/copper-meter-setters/horizontal-inlet-outlet/b-2470-2anshown/
  - Mueller: 2": https://www.muellercompany.com/water-works/service-brass/copper-meter-setters/horizontal-inlet-outlet/h-1423-2n-shown/

Small Meters – Composite Positive Displacement (5/8-inch x ¾”, 1-inch)



Specification Section: 2510, paragraph 2.3.12A and C

Standard Details: 519.01, 519.02

Standard: Complies with the most current AWWA Standard C710 and meets the requirements of NSF 61, Annex G and NSF 372. Meters shall be compatible with *AMI (Advanced Metering Infrastructure)* systems. Main case and bottom plate material - Composite. Maximum operating pressure = 150 psi. Registers to read in 100’s of gallons.

Approved Manufacturer/Product	Manufacturer’s Part Number	Size
☐ SENSUS	☐ accuSTREAM Item # SACCPGERTRPL ☐ accuSTREAM Item # SACCUTRPL1CG	☐ 5/8-inch x ¾-inch ☐ 1-inch
☐	☐	☐

LINKS TO MANUFACTURERS:

- SENSUS: https://sensus.com/products/accustream/

Large Meters – Compound (2-inch through 10-inch)



Specification Section: 2510, paragraph 2.3.12C

Standard Details: 519.03, (2" water meter); 519.04 (3" through 10" water meter)

Standard:

The OMNI+ C2 meter meets and far exceeds the most recent revision of AWWA Standard C701 and C702 class II. Additionally, the meter does not require a valve to meet these standards. Each meter is performance tested to ensure compliance. All OMNI meters are NSF/ANSI Standard 61, Annex F and G approved latest standards. The OMNI+ C² meter consists of two basic assemblies; the main case and the measuring chamber. The measuring chamber assembly includes the "floating ball" impeller with a coated titanium shaft, hybrid axial bearings, integral flow straightener and an all-electronic programmable register with protective bonnet. The main case is made from industry proven Ductile Iron with an approved NSF epoxy coating. Main case features are easily removable measuring chamber, unique chamber seal to the main case using a high pressure O-ring, testing port and an AWWA compliant strainer. Meters and Electronic Registers are compatible with current Sensus AMR systems and other AMI communication systems that use the Sensus UI1203 protocol. 200 psi maximum operating pressure. Up-flow Integral Strainer: The OMNI+ C² with the AWWA compliant "V" shaped strainer, with removable strainer cover, uses a stainless steel screen along with Floating Ball Technology (FBT) on the upflow (inlet end). The removable strainer cover is to permit easy access to the screen for routine maintenance.

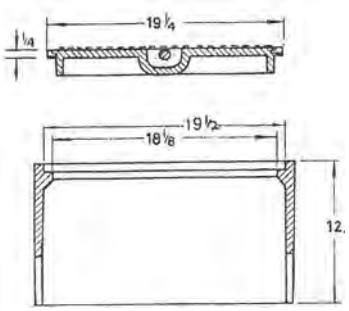
Meters shall be compatible with *AMR (Automated Meter Reading)* systems.

Registers to read in 100's of gallons. Meters to be provided with strainers upflow.

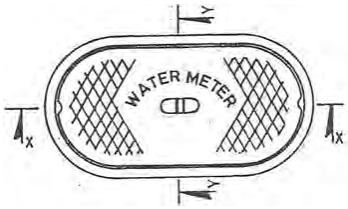
Approved Manufacturer/Product	Number	Size
☐ SENSUS	☐ Sensus OMNI C2 ☐ Sensus OMNI T2 (Irrigation)	☐ 2-inch through 10-inch ☐ 2-inch through 10-inch
☐	☐	☐

LINKS TO MANUFACTURERS:

- SENSUS OMNI: https://www.xylem.com/en-us/brands/sensus/sensus-products/omni-compound-c-water-meters/



Meter Boxes



Specification Section: 2510, paragraph 2.3.12, A and B

Standard Details: 519.01, 519.02, 519.03

Standard:

Polymer: Meter Box and Lid (5/8" x ¾" and 1" meter services); Solid black polymer lid ordered predrilled for AMR/AMI remote readout. H/20 poly lid w/ 2 pcs #5 rebar cast inside lid, recessed hole for Sensus Antenna;

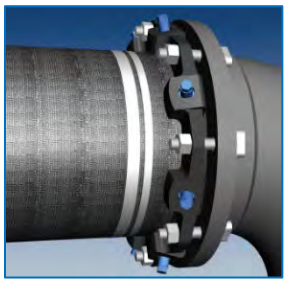
Cast iron: 18"x30", Material Spec: ASTM A48 Class 35B (Capitol Foundry MBX-5A)

Approved Manufacturer/Product	Number	Size
☐ Capital Foundry of Virginia, Inc.	MBX-5A (18"x30")	1 ½" and 2" meter services
☐ TriCast, Selma, NC	TriCast-MBX-1-TOC-set MS-T-MBX1-TOC-L/O (Lid only)	5/8" x ¾" and 1" meter services

LINKS TO MANUFACTURERS:

- Capital Foundry of Virginia, Inc.: https://www.capitolfoundry.net/meter-boxes
- Tricast, Selma, NC: https://www.tricastnc.com/products

Mechanical Joint Restraint (Restrainer) Glands



Specification Section: 2510, paragraph 2.1.2.B.3

Standard Details: 512.02, 512.05, 512.08, 513.02, 514.04, 514.05, 514.06

Standard: ASTM A536, grade 65-45-12 ductile iron, Working press 350-psi for 3" thru 16"; 250-psi for 18" and larger; shall conform to ANSI/AWWA C110/A21.10 and to the requirements of either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53. Hardware (T-Bolts and nuts) to be grade 316 stainless steel; furnished by Restrain Gland manufacturer.

Approved Manufacturer/Product	Product	
	DIP	PVC
☐ EBBA Iron Sales, Inc.	Megalug Series 1100	Megalug Series 2000PV
☐ The Ford Meter Box Company, Inc.	Uni-Flange Series 1400	Uni-Flange Series 1300
☐ Star Pipe Products	StarGrip Series 3000	PVC StarGrip Series 4000

LINKS TO MANUFACTURERS:

- EBBA Iron Sales, Inc.: http://www.ebaa.com/files/pdf/brochures/Brochure.1100.pdf
- Ford: http://www.fordmeterbox.com/submittals/submittals.php?catSec=U&subSec=Restraint+Devices&heading=Series+1400&table=UFR1400
- Star Pipe Products: http://www.starpipeproducts.com/joint_restraint_catalog_submittal.asp

1-Inch and 2-Inch Air Release Valve



Specification Section: 2510, paragraph 2.2.1

Standard Details: 516.01

Standard: AWWA C512, NSF/ANSI 61-G, minimum 200-psi working press., Type 302 SS floats, bronze trim and buna-n seats, NSF/ANSI 372 certified lead free

Approved Manufacturer/Product	Size	Model
☐ Crispin-Multiplex Manufacturing Co.	☐ 2-inch	☐ Type "N" PL 20
☐ G. A. Industries	☐ 2-inch	☐ Fig 920

LINKS TO MANUFACTURERS:

- Crispin-Multiplex Manufacturing Co.: http://www.crispinvalve.com/crispin%20web%20pdfs/presairweb.pdf
- G. A. Industries: http://www.environmental-expert.com/companies/ga-industries-inc-7996/products/family-distributor-automatic-air-release-valves-244851#distributor-automatic-air-release-valves

2 1/2” through 12” Swing Type Lever and Weight Check Valve



Specification Section: 2510, paragraph 2.2.5

Standard Details: N/A

Standard: AWWA C508, ASTM A126 NSF/ANSI 61, non-slamming, minimum 200-psi maximum working pressure, 400 psi test pressure, epoxy coated interior & exterior, adjustable weight control, bronze disk facing, 304 SS shaft. NSF/ANSI 372 certified lead free

Approved Manufacturer/Product	Size	Model
☐ Mueller	☐ 2-inch through 12-inch	☐ A-2606-6-01
☐	☐	☐

LINKS TO MANUFACTURERS:

- Mueller: https://www.muellercompany.com/water-works/valves/check-valves/mueller%C2%AE-2-12-swing-type-lever-and-weight-check-valves-flxfl/

Tapping Service Saddle





Specification Section: 2510, paragraph 2.3.12 A & B

Standard Details: 513.04

Standard: AWWA C800, 85-5-5-5 All Bronze Double Strap Service Saddles, CC tapered threads, NSF/ANSI 61, NSF/ANSI 372 certified lead free, 150 psi working pressure minimum

Approved Manufacturer/Product	Size	Model
☐ The Ford Meter Box Co.	☐ 1-inch ☐ 1 ½-inch ☐ 2-inch	☐ 202B ☐ 202B ☐ 202B
☐ Mueller (Hymax Bronze Saddle)	☐ 1-inch ☐ 1 ½-inch ☐ 2-inch	☐ BR2B ☐ BR2B ☐ BR2B
☐ Smith-Blair	☐ 1-inch ☐ 1 ½-inch ☐ 2-inch	☐ 325 Series ☐ 325 Series ☐ 325 Series

LINKS TO MANUFACTURES:

- The Ford Meter Box Co.: https://www.fordmeterbox.com/products/item/202b-1110-cc3
- Mueller: https://www.hymaxusa.com/products-main/hymax-tap/hymax-bronze-saddle/bronze-saddle-br-1b-br-2b-and-br-1s-br-2s
- Smith-Blair: https://www.xylem.com/en-us/products--services/pipe-fittings/service-saddles/325-service-saddle/

			FITTING BY TYPE OF PIPE				
			C900	DIP	CI	AC	HDPE
The Ford Meter Box Co.	1-inch	202B	202BS	202B	202B	202B	NO
	1 ½-inch	202B	202BS	202B	202B	202B	NO
	2-inch	202B	202BS	202B	202B	202B	NO
Mueller (Hymax Bronze Saddle)	1-inch	BR2B	BR2B	BR2B	BR2B	BR2B	NO
	1 ½-inch	BR2B	BR2B	BR2B	BR2B	BR2B	NO
	2-inch	BR2B	BR2B	BR2B	BR2B	BR2B	NO
Smith-Blair	1-inch	325 Series	325	325	325	NO	NO
	1 ½-inch	325 Series	325	325	325	NO	NO
	2-inch	325 Series	325	325	325	NO	NO

Cast Couplings
(Straight Connection)

(X-Ref: Sewer Repair Coupling, as applicable)





Specification Section: 2510, paragraph 2.3.2 (excluding restraint spec)

Standard Details: N/A

Standard:
End rings and center rings are cast from ASTM A536 Ductile Iron, Sleeve type coupling w/ Styrene Butadiene Rubber (SBR) gaskets meeting ASTM D2000 MBA 710, Minimum working pressure to be 150 psi working pressure. Coatings to be fusion bonded epoxy.
Top Facing Single-Bolt Coupling: ASTM A53 Grade A Steel with EPDM compounded per ASTM D2000, 100% fusion bonded epoxy for enhanced corrosion protection, average thickness = 14 mm. End rings to meet ASTM A283 Grade C steel. Connects two pipes of the same or different OD pipes and materials, up to 1.3" range.
All couplings to meet or exceed standards AWWA C219, NSF 61, NSF 372.
Note: Flexible couplings do not restrain axial forces on piping.

Approved Manufacturer/Product	Model	Size
☐ Hymax (Mueller Brand)	☐ Hymax 2 Wide-Range Coupling	2-inch through 12-inch
☐ Romac	☐ 501	6-inch through 24-inch
☐ Smith-Blair	☐ 411	6-inch through 24-inch
☐ The Ford Meter Box Co.	☐ FC1 Series	2-inch through 12-inch

LINKS TO MANUFACTURES:

- Hymax (Mueller Brand): https://www.hymaxusa.com/products-main/hymax-2
- Romac Industries, Inc: http://www.romac.com/couplings
- Smith-Blair: https://www.xylem.com/siteassets/brand/smith-blair/resources/brochure/411-steel-couplings-for-steel-pipe-pb.pdf
- The Ford Meter Box Co.: https://assets.fordmeterbox.com/catalog/m/Cast-Pipe-Coupling-Catalog.pdf



Ductile Iron Transition Couplings

(X-Ref: Sewer Repair Coupling, as applicable)





Specification Section: 2510, paragraph 2.3.5 (excluding restraint spec)

Standard Details: N/A

Standard:
ASTM A536 Ductile Iron, Grade 65-45-12, Bolts AWWA C111/ANSI A21.11, Minimum 150 psi working pressure per AWWA C219. Corrosion resistant alloy bolts and nuts. Nitrile (Buna-N) gaskets per ASTM D2000. Coatings to be fusion bonded epoxy.
Top Facing Single-Bolt Coupling: ASTM A53 Grade A Steel with EPDM compounded per ASTM D2000, 100% fusion bonded epoxy for enhanced corrosion protection, average thickness = 14 mm. End rings to meet ASTM A283/A283M Grade C steel. Connects two pipes of the same or different OD pipes and materials, up to 1.3" range.
All couplings to meet or exceed standards AWWA C219, NSF 61, NSF 372.
Note: Flexible couplings do not restrain axial forces on piping.

Approved Manufacturer/Product	Model	Size
☐ Dresser	☐ 253 Modular Cast coupling	2-inch through 16-inch
☐ Ford	☐ FC2A Transition Coupling	3-inch through 12-inch
☐ Hymax (Mueller Brand)	☐ Hymax 2 Wide-Range Coupling	2-inch through 12-inch
☐ Smith-Blair	☐ 441 and ☐ 461	

LINKS TO MANUFACTURES/SUPPLIERS:

- Dresser: https://www.anodeengineering.com/wp-content/uploads/dresser_style_253.pdf
- Ford: https://www.fordmeterbox.com/products/item/fc2a-1000-1000
- Hymax (Mueller Brand): https://www.hymaxusa.com/products-main/hymax-2/hymax-2-coupling
- Smith-Blair: https://www.xylem.com/en-us/products--services/pipe-fittings/couplings/441-omni-cast-couplings/

Flanged Coupling Adapters

(For joining flanged fittings, valves, or meters to plain end pipe)





Specification Section: 2510, paragraph 2.3.12.C

Standard Details: 519.04

Standard: ASTM A536 65-45-12 Ductile Body and End Ring, SBR gaskets per ASTM D2000, Flange O-Ring to be NBR (Buna-N) per ASTM D2000, certified to NSF/ANSI 61 and NSF/ANSI 372 , AWWA C219, Minimum 150 psi working pressure. Finish to be Fusion-Bonded epoxy per AWWA C213.
Note: Flexible couplings do not restrain axial forces on piping.

Approved Manufacturer/Product	Model	Size
☐ The Ford Meter Box Co.	☐ FFCA Style	3-inch through 10-inch
☐ Romac	☐ FCA501	3-inch through 16-inch
☐ Smith-Blair	☐ 912 (OMNI)	3-inch through 12-inch

LINKS TO MANUFACTURES:

- The Ford Meter Box Co.: https://assets.fordmeterbox.com/submittals/FFCA-xxx.pdf
- Romac: https://romac.com/fca501
- Smith-Blair: https://www.xylem.com/en-us/free-text-search/?currentpageid=554&page=1&pagesize=24&keyword=912+omni



Stainless Steel All- (when ordered by



Thread Rods (ATR) Town Engineer)

Specification Section: N/A

Standard Details: 512.04, 512.06

Standard: ASTM A193 type 316 or T316 Stainless Steel all-thread rods, plate washers, and heavy hex nuts (ASME B18.2.2) meeting ASTM F593, ASTM F594 and ASTM A751 (Chemical),
Threads: Parts shall be the coarse threaded series as specified in the latest issue of ANSI / ASME B18.2.1.
Tensile Strength: ¼" to 5/8" diameter to be 100 ksi min. to 150 ksi max.; ¾" to 1 ½" diameter to be 85 ksi to 140 ksi max.
Minimum Yield Strength: 45 ksi

Approved Manufacturer/Product	Size	Model
☐ Portland Bolt & Manufacturing Co.	☐ ½-inch through 1 1/2-inch diameter	☐ 316 SS ATR, washers & nuts
☐ Industrial Threaded Products	☐ ½-inch through 1 1/2-inch diameter	☐ 316 SS ATR, washers & nuts

LINKS TO MANUFACTURERS:

- Portland Bolt & Manufacturing Co.: https://www.muellercompany.com/water-works/valves/check-valves/mueller%C2%AE-2-12-swing-type-lever-and-weight-check-valves-flxfl/
  https://www.portlandbolt.com/technical/specifications/astm-f593/
- Industrial Threaded Products: https://itpbolt.com/itpproduct/threaded-rod/

Bore and Jack Operations

Specification Section: 2510, paragraph 2.1.5A; 2530 paragraph 2.1.3A

Standard Details: C07.01, C07.02

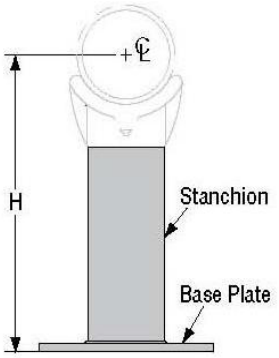
Standard: ASTM A139, grade B steel pipe casing, ASTM A283

Approved Vendors	Casing Spacers/Spiders	End Seals
See Bore & Jack Operations under Sewer		

Pipe Saddle Support
(With U-Bolt)







Specification Section: 2510, paragraph 2.3.11

Standard Details: 519.04, 519.08

Standard:

1. Cast iron (Grinnell): Cast iron stanchion saddle with steel yoke and nuts; 14" through 36" carbon steel saddle with steel yoke; 4" through 12" steel saddle. Complies with Federal Specification A-A-1192A (Type 37), ANSI/MSS SP-69 and MSS SP-58 (Type 37). Specify 63P pipe stanchion.

2. **Steel (Standon)**: Saddle Strap & Base Plate ASTM A36, ASTM A53/ASTM A513 tubing, ASTM A36 Thread stud, grade ASTM A307.

- Finish to be hot dipped galvanized.
- Provide neoprene liner to isolate pipe from saddle.

Approved Manufacturer/Product	Dry Conditions	Wet or Harsh Corrosive
☐ ASC Engineered Solutions (Grinnell)	☐ Figure 259 with 63P Pipe Stanchion	☐
☐ Standon Pipe Supports, Inc.	☐ Standon Model S92	☐ Standon Model S92

LINKS TO MANUFACTURERS/SUPPLIERS:

- ASC Engineered Solutions: https://www.asc-es.com/products/259-pipe-saddle-support-with-u-bolt
- Standon Pipe Supports, Inc.: http://www.standon.net/pdf/s92specsheet.pdf

Detectable Warning Tape
(required on all open cut service lines)



Specification Section: 2510, paragraph 2.3.3.A

Standard Details: 511.01

Standard: ASTM D2103, ASTM D882, ASTM D2578 with permenant messaging “WATER LINE BELOW” repeated along the length of the tape, color coded background that conforms to APWA uniform color code specification (BLUE for water) with silver and black ink letters, lead free, detectable by conductive and inductive methods, 5 mills overall thickness, 0.35 mil foil thickness.

Approved Manufacturer	Product	
☐ Empire Level Mfg. Corp.	☐ Magnatec	

LINKS TO MANUFACTURES:

- Empire Level Mfg. Corp https://www.empirelevel.com/underground-tape.php

Copper Tracer Wire
(when ordered by Engineering Director)





Specification Section: Not Applicable

Standard Details: 511.01, 513.01, 513.02, and 513.03

Standard: #12 AWG Blue insulated solid or stranded copper wire, Voltage: 600V rated; XLP/USE-2/RHH/RHW-2, direct bury listed.

Approved Manufacturer:	Product	
☐ Service Wire Company	SERVICESOLAR® (PV) RHW-2	Multi-strand
☐ Southwire	Type RHH, RHW-2, USE-2	Multi-strand
☐ USA Wire & Cable	USA12-01USE2	Multi-strand
☐ Wire & Cable To Go	12 AWG Solid Tracer Wire, PE-45 Insulation	Solid Single Strand

LINKS TO MANUFACTURERS:

- Service Wire Company: https://www.servicewire.com/Products/PV-600V.htm
- Southwire: http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetOEM7 https://www.southwire.com/wire-cable/building-wire/copper-rhh-rhw-2-use-2/p/BW5
- USA Wire & Cable: https://www.usawire-cable.com/pdfs/USE-2_XLP.pdf
- Wire & Cable To Go: https://www.wireandcableyourway.com/12-awg-solid-tracer-wire-pe-45-insulation-500ft-or-1000ft-spool

RFID* Marker Balls with iD Read/Write
*Radio Frequency ID





Specification Section: 02275 paragraph 2.2.4; 02530 paragraph 2.2.21; 2510 paragraph 2.3.4

Standard Details: C01.04

Standard: 4-inch diameter self-leveling programmable, water-tight polyethylene, passive location marker, bury depth range: 5 ft depth, 100 to 200 ft spacing linearly. Works without any external power source. The locator transmits a signal to the buried marker and the marker returns the signal to the locator, indicating the marker's exact position. Marker must be capable of integrating with GIS system. Refer to **Detail C01.04** for marker ball bury, spacing and locations. Utility type: General Purpose, Reclaimed Water, Potable Water, Wastewater, color coded to APWA standards.

Approved Manufacturer	**Product**	
☐ 3M	☐ 1400 Series EMS iD Ball Markers	Water: 1423-XR/iD Sewer: 1424-XR/iD
☐ Tempo Communications	☐ Omni Marker II	Water: OM-08 Sewer: OM-05

LINKS TO MANUFACTURES:

- 3M: https://www.3m.com/3M/en_US/p/d/b00011108/
- Tempo Communications: https://www.tempocom.com/omnimarker-lp/

Streets & Drainage
PRE-APPROVED MATERIAL/PRODUCT LIST
Town of Clayton, NC

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Corrugated HDPE Double Wall Culvert Pipe
(includes tees, elbows, & end sections)

Specification Section: 02630, paragraph 2.1.2

Standard Details: N/A

Standard: AASHTO M 252 and 294, classification Type S (smooth interior) w/ integral bell & spigot. Pipe to have been evaluated by National Transportation Product Evaluation Program (NTPEP). Interior wall to have a Manning's "n" value of 0.012. Pipe Tees and Elbows to meet AASHTO M294, Section 7.8. Joints to be soil-tight meeting ASTM F477 and water-tight



Approved Manufacturer/Product	Product	Size
☐ Advanced Drainage Systems, Inc. (ADS)	☐ N-12	
☐ Hancor (a division of ADS, Inc.)	☐	
☐	☐	

LINKS TO MANUFACTURERS:
- ADS: https://www.adspipe.com/pipe/n-12-dual-wall-pipe

Last Revision: 9/12/24
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Corrugated Polypropylene (CPP) Double Wall Culvert Pipe
(includes end treatments, pipe tees, & elbows)

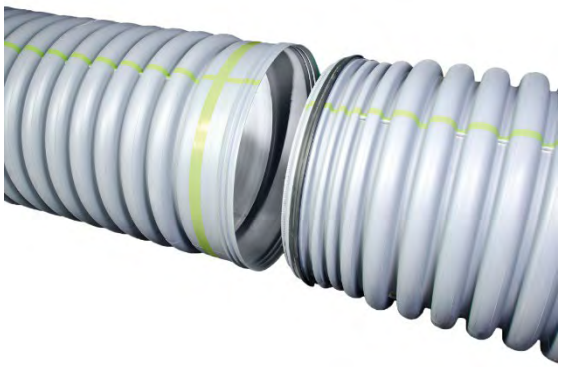
Specification Section: 02630, paragraph 2.1.3

Standard Details: N/A

General Standard:
Polypropylene culvert pipe that meets AASHTO M 330 for Type S or Type D, or ASTM F2881 or ASTM F2764 Double or Triple wall; and has been evaluated by NTPEP; smooth interior.

End Treatments, Pipe Tees and Elbows:
End treatments, pipe tees and elbows shall meet AASHTO M 330, Section 7.7, or ASTM F2764, Section 6.6.

Markings:
Clearly mark each section of pipe, end section, tee and elbow and other accessories according to the NCDOT's Polypropylene Pipe QC/QA Program:
(1) AASHTO or ASTM Designation
(2) The date of manufacture
(3) Name or trademark of the manufacturer



Approved Manufacturer/Product	Product	Size
☐ Advanced Drainage Systems, Inc. (ADS)	☐ HP Storm Dual Wall Pipe	
☐ Hancor (A division of ADS, Inc.)	☐ Model HP – Storm Dual Wall Pipe	
☐	☐	

LINKS TO MANUFACTURERS:
- ADS: https://www.adspipe.com/pipe/hp-storm-dual-wall-pipe
- Hancor: https://www.environmental-expert.com/products/hancor-model-hp-storm-dual-wall-pipe-209721

Last Revision: 6/12/23
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Reinforced Concrete Pipe for Concrete Culvert & Storm Drain
(Pipe & Flared Ends)

Specification Section: 02630, paragraph 2.1.1 & 2.2.4

Standard Details: 636.01

Standard:

- **Round**:
  1. **Tongue and Groove Mastic Compound Joint, ASTM C76/AASHTO M170**, Class III, Class IV or Class V; Wall B Min, Sizes 15" through 144" in diameter ,
  2. **Tongue and Groove Joint, ASTM C655/AASHTO M242**: Similar to ASTM C76 pipe except that the pipe may be designed for a specific D-load strength.
- **Elliptical**:
  1. **Tongue and groove mastic compound joint, ASTM C507/AASHTO M207:** Sizes 18 " through 144" in equivalent circular sizes



Round



Elliptical

Approved Manufacturer/Product	Size	Class
☐ Hanson Pipe & Precast	☐ ☐ ☐	☐ III ☐ IV ☐ V
☐ Oldcastle	☐ ☐ ☐	☐ III ☐ IV ☐ V
☐	☐ ☐ ☐	☐ III ☐ IV ☐ V

LINKS TO MANUFACTURERS

- Hanson Pipe & Precast: https://www.rinkerpipe.com/Products/ReinforcedConcretePipe.aspx
- Oldcastle: https://oldcastleinfrastructure.com/product/concrete-pipe-2/

Last Revision: 8/23/22
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Precast Concrete Manholes

Specification Section: 02630, paragraph 2.2.10

Standard Details: Similar to Sewer Detail 532.03

Standard: ASTM C478, Type II Cement, AASHTO M199



Approved Manufacturer/Product	Detail	Size	Other
☐ Cape Fear Precast			
☐ Concrete Pipe and Precast			
☐ Lindsay Precast			
☐ Mack Industries			
☐ Oldcastle Infrastructure			

LINKS TO MANUFACTURERS:

- Cape Fear Precast: (unsafe connection), call for info
- Concrete Pipe and Precast (formerly Carolina Precast): https://www.concretepandp.com/products/sanitary/
- Lindsay Precast: https://www.lindsayprecast.com/sanitary-storm-sewer
- Mack Industries: https://www.mackconcrete.com/precast-concrete-products
- Oldcastle Infrastructure: https://oldcastleinfrastructure.com/product/manholes/

Last Revision: 9/12/24
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Concrete Grade Rings

Specification Section: 02630 paragraph 2.2.10

Standard Details: C06.03

Standard: ASTM C478, Type II Cement.
Thickness: Min. 4/Max. 6". The top grade ring should be 4"; total height shall not exceed 24" from top of casting to first step



Approved Manufacturer/Product	Thickness
☐ Cape Fear Precast	
☐ Concrete Pipe and Precast (formerly Carolina Precast):	
☐ Lindsay Precast	
☐ Mack Industries	
☐ Oldcastle Infrastructure	

LINKS TO MANUFACTURERS:
- Cape Fear Precast: (unsafe connection), call for info
- Concrete Pipe and Precast (formerly Carolina Precast): https://www.concretepandp.com/products/sanitary/
- Lindsay Precast: https://www.lindsayprecast.com/sanitary-storm-sewer
- Mack Industries: https://www.mackconcrete.com/precast-concrete-products
- Oldcastle Infrastructure: https://oldcastleinfrastructure.com/product/manholes/

Last Revision: 9/12/24
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Precast Concrete Catch Basins & Junction Boxes

Specification Section: 02630, paragraph 2.2.11, 2.2.15, & 2.2.19

Standard Details: 633.02, 633.04, 634.01

Standard: ASTM C913, Type II Cement, ASTM C858 reinforced precast drainage inlets (Curb Inlets, Drop inlets and Catch Basins); rated for HS20 as applicable. Joints to meet ASTM C990.



Approved Manufacturer/Product	Thickness
☐ Cape Fear Precast	
☐ Concrete Pipe and Precast (formerly Carolina Precast):	
☐ Lindsay Concrete (formerly Stay-Right)	
☐ Mack Industries	
☐ Oldcastle Infrastructure	

LINKS TO MANUFACTURERS
- Cape Fear Precast: (unsafe connection), call for info
- Concrete Pipe and Precast (formerly Carolina Precast): https://www.concretepandp.com/products/sanitary/
- Lindsay Precast: https://www.lindsayprecast.com/sanitary-storm-sewer
- Mack Industries: https://www.mackconcrete.com/precast-concrete-products
- Oldcastle Infrastructure: https://oldcastleinfrastructure.com/product/manholes/

Last Revision: 9/12/24
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Soil-Tight Gaskets (Butyl Rubber Sealant)

Specification Section: See 02530, paragraph 2.2.17

Standard Details: 633.02, 633.04, 634.01

Standard: Federal Specification SS-S-00210 (210-A), AASHTO M198 and ASTM C990, Type 1, Rope Form, ¾" diameter (min.); Strip Form, ¾" minimum



Approved Manufacturer/Product	Supplemental Information
☐ ConSeal Concrete Sealants, Inc.	☐ CS-102 (only)
☐ Henry Company, Sealants Division	☐ RN103 – Ram-Nek Joint Sealant (Coils) ☐ RN101 – Ram-Nek Joint Sealant (Strips)

LINKS TO MANUFACTURERS:

- ConSeal Concrete Sealants, Inc.: https://conseal.com/products/cs-102-butyl-rubber-sealant/
- Henry Company, Sealants Division.:
  - RN101: https://henry.com/performance-additives/concrete-joint-sealants/rn101-ram-nek-preformed-flexible-gasket-strips
  - RN103: https://henry.com/performance-additives/concrete-joint-sealants/rn103-ram-nek-preformed-flexible-plastic-gasket-coils

Last Revision: 8/23/22
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

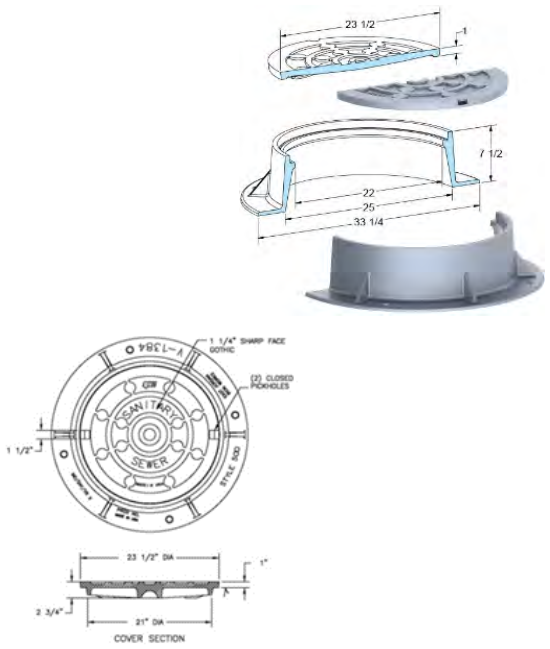
Manhole Frame and Cover
(see Sewer Pre-Approved Product List for Manhole Frame & Cover)

Specification Section:
Storm Drainage: 02630, paragraph 2.2.13
Sanitary Sewer: 02530, paragraph 2.2.10

Standard Details: C06.01, 633.03

Standard: ASTM A48, Grade 35B, AASHTO M105 & M306, uncoated, domestic made, Heavy Duty

Storm Drainage Cover to be embossed to read as shown on Standard Detail 633.03



Approved Manufacturer/Product	Standard	Notes
☐ Capitol Foundry of Virginia, Inc.	MH-2001-SS-O	See note above for embossing
☐ East Jordan	V1384 (Product 0NC413800044)	See note above for embossing
☐ Tricast Masonry Supply	MH-2001-SS*O	See note above for embossing
☐ US Foundry	669KL	See note above for embossing

LINKS TO MANUFACTURERS:
- Capital Foundry of Virginia, Inc.: https://www.capitolfoundry.net/manholes
- East Jordan Iron Works, Inc.: https://www.ejco.com/am/en/products/manhole-covers-and-frames?uom=&pagesize=48&pagenum=1&langcode=en_us&productregion=100&sortdirection=desc&defaultsort=score&q=&aId=&an=&firstSearch=false&state= (requires password to enter EJ portal)
- Tricast, Inc.: https://www.tricastnc.com/products
- US Foundry: http://www.usfoundry.com/usfoundry-products/catalog/ringsandcovers/productdetails/669

Last Revision: 9/12/24
Effective Date:

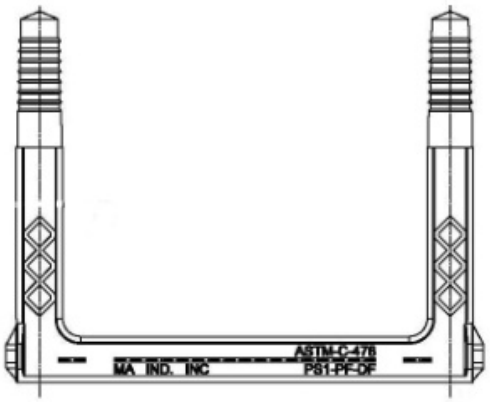
PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Manhole Steps

Specification Section: See 2530, paragraph 2.2.17.B

Standard Details: C06.04, 633.02, 633.04, 634.01

Standard: ASTM C478 and D4101, AASHTO M-199. Copolymer polypropylene plastic with embedded ½" diameter ASTM A615 Grade 60 steel reinforcement.



Manufacturer & Product	Model	Reinforcement
☐ M. A. Industries, Inc.	PS1-PF	½" dia. grade 60 rebar
☐		

LINKS TO MANUFACTURERS:
- M. A. Industries, Inc. https://precast-supplies.com/category/manhole-products/manhole-steps

Last Revision: 8/23/22
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST

Streets & Drainage

Geotextile Fabrics

Specification Section: 02630, paragraph 2.2.6

Standard Details: N/A

Standard: NCDOT Standard Specifications for Roadways and Structures, Section 1056;

- NCDOT Type 1 for Subsurface Drains,
- NCDOT Type 2 for Filter Fabric below rip rap,
- NCDOT Type 3 Class A or B for Silt Fence, and
- NCDOT Type 4 for Soil Stabilization.

Woven



Nonwoven



Approved Manufacturer	Product
☐ Propex	☐
☐ Huesker, Inc.	☐
☐ Tensar Intl. Corp	☐
☐ US Fabrics, Inc.	☐

LINKS TO MANUFACTURES:

- Geotextile Systems by *Propex*: http://propexglobal.com/
- Huesker: https://www.huesker.us/geosynthetics/
- Tensar: http://www.tensarcorp.com/
- US Fabrics Inc.: http://www.usfabricsinc.com/products/categories

Last Revision: 8/23/22
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

Iron Castings
(Catch Basin Grate & Frames, Combination Frame, Cover & Hood)

Specification Section: 02630, paragraph 2.2.14

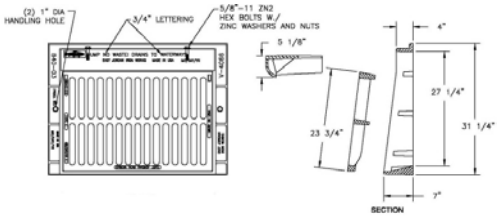
Standard Details: C06.03, 633.02, 633.03, 633.04

Standard: ASTM A48, Grade 35B, Heavy Duty, AASHTO M 306, uncoated.

Specify grate type when ordering (e.g. Type “E”)

2x3 CB shown: EJCO Product 44867261, or approved equal





Approved Manufacturer/Product	Catalog Number/Description	Product No
☐ Capitol Foundry	☐ DI 840.03 Comb Frame, Cover & Hood (NCDOT 840.03*) (*E, F or G Grates) ☐ CB-2004 2x3 Grate & Frame	☐ Same ☐ Same
☐ East Jordan	☐ V4066-1 Comb Frame, Cover & Hood (NCDOT 840.03), **Type E Grate**…….. ☐ V4066-1 Comb Frame, Cover & Hood (NCDOT 840.03), **Type F Grate**……. ☐ V4066-1 Comb Frame, Cover & Hood (NCDOT 840.03), **Type G Grate**…….. ☐ V5660-1 2x3 Grate & Frame	☐ 44066001* ☐ 44066003* ☐ 44066004* *Use with 44066063 hood ☐ 45660050A01
☐ US Foundry	☐ USF 5181 Comb Frame, Cover & Hood (NCDOT 840.03) ☐ USF 4137 (7” high frame)	☐ USF 5181-6420 (type E) ☐ USF 4137-6237

LINKS TO MANUFACTURERS:
- Capitol Foundry: https://www.capitolfoundry.net/catch-basins
- EJCO: https://www.ejco.com/am/en/product/details?productid=3074457345617539409 (Log in and type in item number in search box for the various items listed above)
- US Foundry: (type in item number in search box for other items)
  1. **Model 5181**: https://www.usfoundry.com/usfoundry-products/catalog/products/search?search_text=5181;
  2. **Model 4137**:https://www.usfoundry.com/usfoundry-products/catalog/products/search?search_text=4137

Last Revision: 8/23/22
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

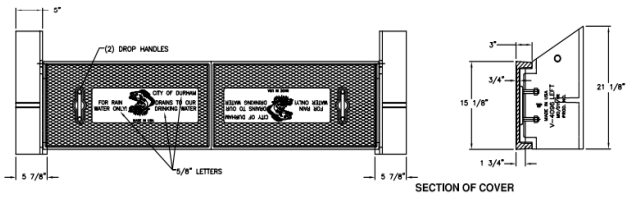
Open Throat Catch Basin Curb Inlet - Iron Casting
(Curb Inlet Frame, Bottom Flange)

Internal Use Only - To be used only with approval of Engineering Director

Specification Section: 02630, paragraph 2.2.14

Standard Details:

Standard:
Frames (Gray Iron): ASTM A48, Grade 35B, Heavy Duty, AASHTO M 306, uncoated,
Cover (Ductile Iron): ASTM A536 70-50-05, 50ksi yield strength, AASHTO M105, uncoated, Environmental Markings, Drop Handle, Type 5



Approved Manufacturer/Product	Catalog Number/Description	Product No
☐ East Jordan	☐ V4096 V4096-2 Set	☐ 44096226C01
☐	☐	☐

LINKS TO MANUFACTURERS:
- EJCO: https://www.ejco.com/am/en/product/details?productid=100-44096226C01&partnumber=44096226C01&uom=imperial (Log in and type in item number in search box for the various items listed above)

Last Revision: 1/12/23
Effective Date:

PRE-APPROVED MATERIAL/PRODUCT LIST
Streets & Drainage

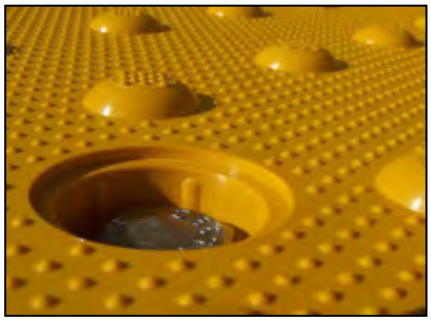
ADA Detectable Warning
System Surface

Specification Section: 02400, paragraph 3.3.1

Standard Details: 405.02, 405.03, 405.15

Standard: Meets ADAAG, PROWAG, and ANSI A117.1 requirements.

Cast-In-Place Composite Paver Tiles: Slip resistant glass and carbon reinforced composite, min 11,600 psi tensile strength, colorfast UV resistant; can either be pre-filled with concrete and set in place or pressed into place in freshly poured concrete. Color to be dark gray or black. Curved in 5' radii increments; pre scored for 10', 15' and 20' Radius.



Manufacturer	Catalog Number/Description	Product
Composite:		
ADA Solutions, Inc.	☐ Cast-In-Place System	☐ ADA-CIP2448_2
	☐ Cast-In-Place Replaceable Radius System	☐ ADA-REP24RAD
	☐	☐

LINKS TO MANUFACTURERS:
- ADA Solutions, Inc.: https://adatile.com/

Last Revision: 9/12/24
Effective Date:

Back to Top

PRE-APPROVED MATERIAL LIST

Draft Revision: _____
Effective Date: _____

Town of Clayton Contract Number:
_____

Date: _____

To: **Engineering Department**
Town of Clayton
111 E. Second St.
Post Office Box 879
Clayton, NC 27528

From: Contractor Name
_____
Address
_____
City, State, Zip
_____

Re: Project Name
_____

"Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."

_____ _____
Contractor Signature Date

Note 1: Please denote (highlight, check numbers, or otherwise identify) the materials from the attached list that you intend to use on this project.

Note 2: Failure to provide complete information will result in delays in the approval process and may affect the project schedule.

Note 3: This list and all substitution information shall be submitted to the Engineer Director **with the Proposal Package**.

00950 - MEASUREMENT & PAYMENT (TOWN FUNDED PROJECTS)

(Last revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Section 1.1 - Trenching, Backfilling & Compaction of Utilities
Section 1.2 - Water Distribution
Section 1.3 - Sanitary Sewer
Section 1.4 - Storm Drainage
Section 1.5 - Earthwork
Section 1.6 - Base Course & Paving
Section 1.7 - Curb & Gutter, Driveways, Sidewalks & Misc. Concrete
Section 1.8 - Items Miscellaneous to all sections

Unit of Measure: A Unit of Measure is a unit that can be defined as either a specific item or product or a unit that can be defined as an end product that, through a process of assembly and/or construction, yields a complete end product that can be quantified as a single unit of measure.

1.1 TRENCHING, BACKFILLING AND COMPACTION OF UTILITIES

Measurements for purpose of payment shall be in accordance with the unit quantities stated in the proposal as defined below. Whenever units of measure, (i.e., Linear Feet, Each, and similar units of measure) are mentioned in a proposal, it shall be interpreted to mean the unit installed in accordance with the plans and specifications, and ready for use. Prices for the following bid items shall include all labor, materials, tools, equipment, hauling, and other incidentals necessary to complete the work as shown on the plans and in accordance with these specifications.

A. **Aggregate Backfill:**

Measurement: Coarse granular fill will be measured by the ton in place in the trench.

Payment: Price per ton for coarse granular fill shall include all materials, equipment, and labor required to furnish and install #57 or #67 stone in the locations designated by the Engineering Director.

B. **Bedding, Haunching, Crushed Stone for Sewer Mains:**

Measurement: Bedding stone is considered incidental to the cost of the pipe.

Payment: Not a pay item.

C. **Excavation and Backfill:**

Measurement and Payment: All excavation and backfill shall be included in the cost of the other items bid – not a pay item.

When the removal of existing structures or materials is classified separately as a contract pay item, payment will be made in accordance with the contract price; otherwise, such work will be considered as incidental work and will not be paid for

directly, but the cost shall be included in the unit price for other items of work. In either case, such price or prices shall be full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the work.

D. **Exploratory Excavation**

Measurement: Such excavation, where ordered by the Engineering Director will be measured by the cubic yard.

Payment: The cost of such excavation, where ordered by the Engineering Director, will be paid at the contract unit price bid, per cubic yard.

E. **Foundation Stone:**

Measurement: Foundation stone used in stabilizing the bottom of trenches will be field measured in the trench by the ton, complete in place.

Payment: When the Engineering Director directs the use of foundation stone, foundation stone shall be paid for at the contract unit price for foundation stone by the ton. Payment shall include all materials and labor incidental to the placing of the stone and any additional extra depth of trench or excavation necessary to accommodate the stone including disposal of unusable material necessary to allow for placement of the foundation stone.

F. **Geotextiles – Separation Fabric** (NCDOT Type 4 [or as otherwise specified])

Measurement: Geotextile Separation Fabric placed over either an earthen or stone subgrade shall be field measured by the horizontal exposed surface of the fabric, complete in place, to the nearest the square yard. No compensation for overlaps or waste.

Payment: When a geotextile separation fabric is directed to be placed by the Engineering Director, the geotextile shall be paid for at the contract unit price for separation fabric by the square yard. Payment shall include all materials, laps, waste, placement, staking, and labor incidental to the placing of the separation fabric including disposal of unused or waste material.

G. **Pavement Removal, Replacement, Repair or Street Rehab**

Measurement: See Section 1.6 Base Course & Paving, paragraph I, *Pavement Removal, Replacement, Repair or Street Rehab*. See also Specification Section 02275 – *Trenching, Backfilling, and Compaction of Utilities*, paragraph 3.7, *Pavement Repair and Replacement*.

Payment: See Section 1.6 Base Course & Paving, paragraph I, *Pavement Removal, Replacement, Repair or Street Rehab*.

H. **Concrete Sidewalk Removal, Replacement & Disposal**

Measurement: See Section 1.7 - Curb & Gutter, Driveways, Sidewalks & Misc. Concrete, Paragraph A, *New Concrete Sidewalks* and Paragraph B, Replacement of Concrete Sidewalks.

Payment: See Section 1.7 - Curb & Gutter, Driveways, Sidewalks & Misc. Concrete, Paragraph A, *New Concrete Sidewalks* and Paragraph B, Replacement of Concrete Sidewalks.

I. **Concrete Driveway Removal, Replacement & Disposal**

Measurement: See Section 1.7 - Curb & Gutter, Driveways, Sidewalks & Misc. Concrete, Paragraph C, *New Concrete Drives and Entrances* and Paragraph D, *Replacement of Concrete Drives and Entrances*..

Payment: See Section 1.7 - Curb & Gutter, Driveways, Sidewalks & Misc. Concrete, Paragraph C, *New Concrete Drives and Entrances* and Paragraph D, *Replacement of Concrete Drives and Entrances*.

J. **Remove and Replace Asphalt Driveway**

Measurement: See Section 1.6 Base Course & Paving - Paragraph C, *Asphalt Driveway – Remove and Disposal* and Paragraph D, *Asphalt Concrete Pavement*.

Payment: See Section 1.6 Base Course & Paving - Paragraph C, *Asphalt Driveway – Remove and Disposal* and Paragraph D, *Asphalt Concrete Pavement*.

K. **Rock Excavation, Trench:**

Measurement: Where rock excavation is to be measured for payment, quantities will be as determined by the Town. Rock excavation will be measured by the cubic yard. For pay purposes, dimensions shall be computed as the difference in elevation between the top and bottom of the rock (as determined by the Town) multiplied by the specified trench width for the pipe size being laid. Where rock is encountered in the bottom of the trench, the maximum depth for payment purposes shall be 6 inches below the bottom of the pipe. Rock excavation shall consist of the removal and satisfactory disposal of all materials, which in the opinion of the Engineering Director, cannot be excavated except by a track-mounted power excavator, equivalent to a Caterpillar Model No. 325 or equivalent equipped with new rock teeth. Practical excavation is defined as the ability to remove at least 30 cubic yards during one hour of continuous digging. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.

Payment: Rock excavation will be paid for at the contract unit price per cubic yard for rock excavation and shall include all labor, materials, insurance, blasting plans, blast monitoring, post-blast reports, scaling and stabilizing rock cuts, mats, signage, traffic control, tools, equipment and incidentals necessary to excavate and dispose of rock off site, backfilling the excavated trench to the bottom of the pipe with select backfill material, and shall include the cost of removing all excavated materials which are not suitable for backfill. No payment will be made for rock that has been excavated subsequent to ripping operations.

L. **Sheeting and Bracing (Piling)**

Measurement and Payment: Payment for sheeting and bracing, except when ordered to be left in place, and all other work incidental to sheeting and bracing, shall

not be made separately unless specified or as shown on the plans or as directed by the Engineering Director, but shall be included in the bid price for other items.

When specified, payment for “Timber Sheeting Left in Place” shall be made at the contract unit price bid per 1000 board feet.

When specified, payment for “Steel Sheet Piling” shall be made at the contract unit price bid per square foot.

When specified, payment for “Steel Sheet Piling Left in Place” shall be made at the contract unit price bid per square foot.

M. **Select Fill:**

Measurement: Trench excavation determined to be unusable by the Engineering Director, or his representative, resulting from material which may be unsatisfactory (as defined in paragraph 2.1.1.E of *Section 02275, Trenching, Backfilling, and Compaction of Utilities*), non-compactable, naturally wet (when removed from trench) and otherwise unusable due to too high a moisture content for compaction (as opposed to unprotected soil exposed carelessly to rain which becomes unusable in which case there is no claim for payment for trench borrow). Measurement shall be made along the centerline of the pipe and the pay quantity shall be determined based upon the depth of fill placed times the maximum trench width (pipe outside diameter plus 2 feet). Selected granular backfill in excess of the maximum quantity, as specified, shall be furnished and placed by the Contractor.

Payment: Select Fill will be paid for at the contract unit price by the compacted cubic yard, in place, and shall include all material, equipment, and labor to furnish, haul, placement, compact the approved material, and haul off unsuitable material, complete in place, in the locations as designated on the drawings or as approved by the Engineering Director.

N. **Other:** Other items shall be paid for as provided under Section 1.8, Items Miscellaneous to All Sections or as stated in the Proposal.

1.2 WATER

Measurements for purpose of payment shall be in accordance with the unit quantities stated in the proposal as defined below. Whenever units of measure, (i.e. linear feet, each, and similar units of measurement) are mentioned in a proposal, it shall be interpreted to mean the unit installed in accordance with the plans and specifications, and ready for use. Prices for the following bid items shall include all labor, materials, tools, equipment, and other incidentals necessary to complete the work as shown on the plans and in accordance with these specifications.

A. **Bedding Stone for Water Pipe:**

Measurement: When called for in the proposal or on the plans or when directed by the Engineering Director, aggregate material used for bedding water lines will be measured by the ton of pipe bedding material placed.

Payment: Pipe bedding stone will be paid for at the contract unit price per ton for pipe bedding material, complete and in place.

B. **Temporary Blow-Offs:**

Measurement: Temporary blow-offs will be measured on a per each basis for the number of blow-offs installed.

Payment: Temporary blow-offs will be paid for at the contract unit price per blow-off for the size specified, and all materials incidental to the installation of the blow-off, complete in place. This price shall include, but is not necessarily limited to, valve, piping, plug, fittings, valve box(es), bedding material, thrust collar, rodding, blocking, riser, and other related incidentals as shown on **Standard Detail 514.01**.

C. **Concrete Encasement**

Measurement: Payment for furnishing concrete encasement will be at the unit price bid per cubic yard for the class of concrete stated in the proposal.

Payment: The unit priced stated in the proposal shall include the cost of additional depth of excavation, forming, the furnishing and placing of concrete, cofferdams, laying of pipe line to grade but excluding the cost of the pipe itself, complete in place, including all labor, equipment, and material, necessary and all other work incidental to the complete installation of the concrete encasement in accordance with the specification and details shown on the plans. Payment will be made to neat lines of construction shown on the plans with no allowance being made for extra ditch width.

D. **Concrete Piers**:

Measurement: Reinforced concrete piers shall be measured on an each basis based on the height and the structural details shown on the contract drawings.

Payment: This item will be paid for at the contract unit price bid for concrete piers complete in place, including all labor, equipment, and material, necessary for furnishing, excavating, disposal of excess material, stone bedding, reinforcement, anchor bolts, steel straps, concrete, testing, forming, concrete finishing, backfilling, restoration of grade, and all other work incidental to the complete installation of the concrete piers in accordance with the specification and details shown on the plans. Payment will be made to neat lines of construction shown on the plans with no allowance being made for extra ditch width.

E. **Connecting to Existing Mains**

Not a pay item. Fittings and specialty items used in making the connections will be measured and paid for at the unit price bid by the Contractor for “Fittings” and at the unit price bid for “Tapping Sleeves and Valve.”

F. **Dechlorination**

Not a pay item. The associated work, materials, and labor involved in dechlorinating water is incidental to the cost of the water main construction and shall be included in other bid items.

G. **Detectable Warning Tape.**

Not a pay item. The associated cost of detectable warning tape, its placement, labor, and equipment involved in placing detectable warning tape is to be considered incidental to the cost of the main construction.

H. **Directional Boring**

Measurement: The method of measurement will be based on the per foot of bore diameter of product measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation.

Payment: Payment will be full compensation for all work specified in this Section, including furnishing and installing pipe or conduit, from plan point of beginning to plan point of ending at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration of the site. Bundled product in a single bore will be paid for as a single bore based on the required drill bit head or back reamer head size. Separate payment shall not be made for individual products in a bundle.

The installation and attachment of tracking conductors (wire or tape) will be included in the cost of the bore and will not be paid for separately.

No payment will be made for failed bore paths, injection of flowable fill, products taken out of service or incomplete installations.

No payment will be made for directional boring until a Bore Path Report has been delivered to the Engineering Director. After the Engineer Director's acceptance of the Bore Path Report, payment will be made in the amount of 70% of the unit price bid, for Directional Boring. The remaining 30% of the unit price bid will be made after submittal of As-Built Plans.

I. **Ductile Iron Pipe (For Mains):**

Measurement*:* By the linear foot. All pipes shall be measured from the exact beginning of the pipe to the end of the line without deduction for fittings (i.e. fittings and valves) and shall be made through casings. 6-inch hydrant leg lead-in pipe is not included but is considered incidental to the cost of hydrant installation.

Payment: The accepted quantities of water line pipe will be paid for at the contract unit price per linear foot of the various types, depths, and size pipe specified (fittings, valves, and specialty items are paid separately), complete in place. This price shall include labor, equipment, materials, trench excavation (excluding select fill and rock as defined in item 1.1 K), shoring, or use of trench box, installation, concrete thrust blocking, making connections to existing mains, installing in existing casing, pumping, backfilling, compaction, testing of failed trenches, disposal of excess material, pressure testing, chlorinating, dechlorination, bacteriological testing, and all other

work incidental to the complete installation of the mains in accordance with these specifications. Fittings, valves, and specialty items are paid separately.

J. **Ductile Iron Pipe, Bored and Jacked**

Measurement: Measurement of Ductile Iron Pipe, bored and jacked, shall be measured by the linear feet of pipe installed. Bored and jacked Ductile Iron Pipe shall include any excavation, any backfill, bore, jacking, the pipe, dewatering, clean up, restoration and any other work required for a complete and acceptable in place installation.

Payment: Ductile Iron Pipe, bored and jacked will be paid for at the contract unit price per linear foot for pipe bored, complete, and acceptable in place. The price shall be full compensations for pipe, labor, equipment, and all other work incidental to the complete installation of the mains in accordance with these specifications. Fittings, valves, and specialty items are paid separately. Payment will only be made upon acceptance by the Town of Clayton and the Consulting Engineer that the bore is installed to the proper elevation and grade. Any deviations, errors, or unacceptable conditions noted by the Town of Clayton or the Johnston County office of the North Carolina Department of Transportation (if applicable) will be the responsibility of the Contractor to correct to the full satisfaction of the above mentioned parties without additional compensation.

K. **Encasement Pipe (bored):**

Measurement: Steel casing pipe of the wall thickness and diameter specified will be measured by the linear feet of steel casing pipe installed.

Encasement of water lines by the dry bore and jacking method shall include any excavation, any backfill, the encasement pipe, bore, jacking, spiders, the end seals, dewatering, clean up, restoration and any other work required for a complete and acceptable in place installation.

Payment: Steel casing pipe will be paid for at the contract unit price per linear foot per diameter per thickness for steel casing pipe bored, complete, and acceptable in place. Payment will only be made upon acceptance by the Town of Clayton and the Consulting Engineer that the bore is installed to the proper elevation and grade and ready for the installation of the designed carrier pipe without any additional compensation. Any deviations, errors, or unacceptable conditions noted by the Town of Clayton or the Johnston County office of the North Carolina Department of Transportation (if applicable) will be the responsibility of the Contractor to correct to the full satisfaction of the above-mentioned parties. Lines either off on grade or alignment shall be rejected or corrected in a manner approved by the Town's Engineer. *Regardless of the number of withdrawal and reattempts, the bore shall be paid one time for a successful bore on a linear foot basis*. The cost of the carrier pipe is not to be included.

L. **Encasement Pipe (open cut):**

Measurement: Steel casing pipe of the wall thickness and diameter specified will be measured by the linear feet of steel casing pipe installed.

Encasement of water lines by the open cut method shall include any excavation, any backfill, the encasement pipe, spiders, the ends seals, dewatering, clean up, restoration and any other work required for a complete in place installation.

Payment: Steel casing pipe will be paid for at the contract unit price per linear foot per diameter per thickness for steel casing pipe installed by the pipe open cut, complete and in place. Lines either off on grade or alignment shall be rejected or corrected in a manner approved by the Town's Engineer. The cost of the carrier pipe is not to be included.

M. **Excavation and Backfill:**

Measurement and payment: All excavation and backfill for water mains shall be included in the cost of the other items bid – this is not a pay item.

N. **Fittings and Accessories:**

Measurement: Fittings and specialty items used in conjunction with ductile iron or C900 PVC pipe will be measured by the pound.

Payment: Payment for ductile iron fittings shall include all labor, equipment and all materials necessary for installing, making connections to existing mains, tie rods, wedge action restrainer glands, backfilling, testing, sterilizing, and all other work incidental to the complete installation of these fittings in accordance with the specifications.

O. **Fire Hydrants:**

Measurement: Fire hydrants will be measured by the number of hydrants installed on an each basis.

Payment: Price shall include all labor, equipment, and all materials (including extensions and fittings), necessary to install the hydrant including construction staking, #57 stone, drainage pit, thrust restraint, fire hydrant pavement markers, Storz nozzles, 6-inch hydrant leg lead in pipe, hydrant leg valve, valve box, painting, testing and disinfecting, complete and in place. The cost of surveying for staking hydrant location is to be included in the cost of the hydrant unless an item is provided in the proposal for utility construction staking whereupon the costs shall then be included in that line item. Pavement repair, select fill, and stone for trench stabilization are not to be included in the bid price for the fire hydrant. See Standard Details **514.04** and **514.05**.

P. **Fire Hydrants Removal:**

Measurement: Fire hydrants will be measured by the number of existing fire hydrants removed on an each basis.

Payment: Price shall include all labor, equipment, and all materials necessary to remove the hydrant including excavation, backfilling, topsoil, seeding or sod replacement, capping the hydrant lateral, curb/gutter and sidewalk replacement, and delivery of old hydrant to the Water Resources Department (the hydrant shall remain the property of the Town). Pavement repair, select fill, and stone for trench stabilization are not to be included in the bid price for the fire hydrant removal.

Q. **Fire Vaults and Large Meter Vaults:**

Measurement: Vaults for backflow prevention devices, detector check, RPZ, or large meters (meters larger than 2 inches) shall be paid lump sum. Cost for vault is to include all labor, materials, equipment, backfill, compaction, etc. complete and in place. The cost of the vault is to also include the precast reinforced concrete vault (underground installations) or insulated enclosure (above ground installations) and concrete pad, stone bedding, the backflow prevention device and/or meter, gate valves, post indicator valves (if applicable), fittings, check valves, couplings, sleeves, fire department connection (if applicable), hatch, floor drain (if applicable) and drain line, pipe stands, vents, ladder, painting of pipe and fittings (if applicable), defect repair, testing, etc. necessary to render a complete unit as shown on the contract drawings.

Payment: Vault payment will be paid as lump sum.

R. **Flushing Device, Automatic**

Measurement: 2-inch Automatic Flushing Devices shall be paid lump sum. Cost is to include all labor, materials, equipment, tap to main, valve and valve box, tubing, fittings, minimum 4' x 4' x 4" thick (or as shown on the drawings) concrete pad for diffusion plate mounting, device enclosure and mounting, excavation, backfill, compaction, etc. in place to render a complete unit.

Payment: 2-inch Automatic Flushing Device will be paid as a lump sum unit item.

S. **Foundation Stone:**

Measurement: Foundation stone used in stabilizing the bottom of trenches will be measured by the ton, complete in place.

Payment: When the Engineering Director directs the use of foundation stone, foundation stone shall be paid for at the contract unit price for foundation stone by the ton. Payment shall include all materials and labor incidental to the placing of the stone and any additional extra depth of trench or excavation necessary to accommodate the stone including disposal of unusable material necessary to allow for placement of the foundation stone.

T. **PVC Pipe (when applicable):**

Measurement*:* By the linear foot. All pipes shall be measured from the exact beginning of the pipe to the end of the line without deduction for fittings (i.e. fittings and valves) and shall be made through casings. 6-inch hydrant leg lead-in pipe is not included but is considered incidental to the cost of hydrant installation.

Payment: The accepted quantities of PVC water line pipe will be paid for at the contract unit price per linear foot of the various types, depths, and size pipe specified (fittings, valves, and specialty items are paid separately), complete in place. This price shall include all labor, equipment, materials, trench excavation (excluding rock and select fill), shoring, or use of trench box, installation, concrete thrust blocking, marking tape, copper wire with valve boxes, making connections to existing mains, installing in

existing casing, pumping, backfilling, compaction, testing of failed trenches, disposal of excess material, pressure testing, chlorinating, dechlorination, and bacteriological testing and all other work incidental to the complete installation of the mains in accordance with these specifications. No special payment will be made for fittings, specialty items, or pipe used in making connections to existing mains where such connections are noted on the plans.

U. **Removal and Disposal of Asbestos Cement Pipe**

Measurement: When the amount of pipe to be removed is less than 12 feet, the Contractor shall be paid a lump sum per each event. When the amount removed exceeds 12 feet, the Contractor shall be paid the lump sum plus the bid price per linear foot for pipe removed in excess of 12 feet.

Payment: Asbestos Cement Pipe removal will be paid for at the contract unit price per lump sum and/or by the foot as bid and shall include all labor, materials, and equipment to excavate, remove and properly dispose of A/C pipe waste in a landfill approved to receive asbestos. Contractor shall provide documentation to the Town as to the legal disposition of the pipe in accordance with the Solid Waste Disposal Act, as amended from time to time.

V. **RFID Marker Balls with iD Read/Write**

Measurement: RFID Marker Balls with iD Read/Write will be measured on a per each basis for the number of Marker Balls installed.

Payment: RFID Marker Balls with iD Read/Write will be paid for at the contract unit price per Marker Ball for the type and size specified and all materials incidental to the installation of the Marker Balls, complete in place. This price shall include, but is not necessarily limited to, placement, redlining plans if required, programming, bedding material, and other related incidentals as shown on **Standard Details C01.04**.

W. **Tapping Sleeve and Valve:**

Measurement: Tapping sleeve and valve will be measured by the number of each size installed.

Payment: Tapping sleeve and valve price shall include furnishing all materials, equipment, and labor to make a wet tap on an existing line, complete in place, to include valve, valve box, stainless steel tapping tee sleeve, tap, tapping machine, anchor blocks, excavations, backfill, disinfection, and testing of sleeve. Wet taps will be paid for at the contract unit price per tap for the size specified, complete in place.

X. **Testing and Sterilizing**

Not a pay item. The associated work, materials, and labor involved in testing and sterilizing water mains is incidental to the cost of the water main construction and shall be included in other bid items.

Y. **Tie Rods, Restraint Flange, Retainer Glands and Retainer Clamps:**

Measurement: Tie rods, wedge action restrainer glands, retainer glands, and retainer clamps are considered incidental to the cost of construction.

Payment: Not a pay item.

Z. **Thrust Restraints**

Not a pay item. Concrete blocking shall be installed as required for all tees, bends etc. per the applicable standard details. No separate payment shall be made for thrust restraints. The cost of thrust restraints is considered incidental to the cost of the contract unit price bid for each applicable fitting bid.

AA. **Tunneling:**

Measurement: Tunneling will be measured by the linear feet of tunnel installed.

The tunneling method shall include any and all excavation, shoring and bracing, any backfill, steel liner plates and bolts, ventilation system for workers, lagging, spiders, grout plugs, sand-cement grouting of voids, steel drain pipe, French drain, concrete paved invert, the ends seals, dewatering, clean up, restoration and any other work required for a complete in place installation.

Payment: Tunneling will be paid for at the contract unit price per linear foot for diameter installed by the tunneling cut, complete and in place. Payment will only be made upon acceptance by the Town of Clayton and the Consulting Engineer that the tunnel is installed to the proper elevation and grade and ready for the installation of the designed carrier pipe without any additional compensation. Any deviations, errors, or unacceptable conditions noted by the Town of Clayton or the Johnston County office of the North Carolina Department of Transportation (if applicable) will be the responsibility of the Contractor to correct to the full satisfaction of the above-mentioned parties. Unit price does not include the carrier pipe.

BB. **Valves – Air Release Valve & Manhole:**

Measurement: Air/Vacuum Release valves will be measured on a per each basis for the number of units installed.

Payment: Air release valves will be paid for at the contract unit price per air release valve and manhole for the size specified, and all materials incidental to the installation of the air release valve and manhole, complete in place. This price shall include, but is not necessarily limited to, bedding stone, the direct tap and/or saddle, brass plumbing valves, brass street ells and screen, including the doghouse manhole, concrete grade rings (if applicable), and frame and cover, grade adjustments to iron frame if necessary and other incidentals as shown on **Standard Detail 516.01**.

CC. **Valve with Box:**

Measurement: Gate valves and inserting valves will be measured by the number of each size and type of valve installed.

Payment: Gate valves and inserting valves will be paid for at the contract unit price, complete in place, per valve for the type and size specified, complete in place. This

price shall include all labor, equipment, and materials necessary for installing, valve footing (if applicable), furnishing, backfilling, testing, slot cut in valve box for tracer wire, copper wire with valve box, sterilizing and all other work incidental to the complete installation of the valves, with necessary valve box, in accordance with the specifications. Cost for any accessory kit to be included in price of valve.

DD. **Valve Box/Valve Removal:**

Measurement: Valve box/valve removal will be measured by the number of each valve box/valve removed.

Payment: Payment for valve box/valve removed shall be made at the contract unit price for each valve box/valve removed and delivered to the Water Resources Department. Valve box/valve removal shall include valve box removal, removal of the gate valve, plugging of tee, placement of select fill material, compaction, and pavement repair. This price shall include all labor, equipment, materials necessary for removal of valve box(es)/valve(s) and all other work incidental to the complete removal of the valve box(es)/valve(s) in accordance with the specifications.

EE. **Small Water Services (2" or less), Copper Tubing (Pipe) – by open cut:**

Measurement: Measurement of water services shall be made on a per service basis regardless of service pipe material or length.

Payment: The water service pipe shall be paid for at the contract unit bid per service of the size indicated on the drawings, complete and in place, at a minimum depth of 24 inches. The price shall include all equipment, labor, and materials for installation, making tap, furnishing and running service line, setting meter box and setter as applicable, tail piece extension and marker post if applicable, testing and disinfection complete in place in accordance with **Standard Details 519.01, 519.02,** and **519.03** as applicable, curb/gutter and sidewalk replacement if necessary. The Town will furnish and set meter.

FF. **Small Water Services (2" or less), Copper Tubing (Pipe) – by Jacking or Boring:**

Measurement: Measurement of jacked water services shall be made on a per service basis regardless of service pipe material or length.

Payment: The jacked service shall be paid for at the contract unit bid price per service of the size indicated on the drawings, complete and in place. The price shall include all equipment, labor, and materials for installation, making tap, running or punching service line, setting meter box and setter as applicable, testing and disinfection complete in place in accordance with **Standard Details 519.01, 519.02**, and **519.03 as** applicable. The Town will furnish and set meter.

GG. **Water Service Line Replacement:**

Measurement: Water service line replacement shall be measured on an each basis.

Payment: Water service line replacement shall include all materials, labor, and equipment for installation, furnishing pipe, running service line, removal and reconnection of service, testing, disinfection, sidewalk (if necessary) and curb

removal and replacement, complete in place. Payment for pavement removal and replacement is paid under *Pavement Removal and Replacement.*

HH. **Other:** Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.3 SEWER

Measurements for purpose of payment shall be in accordance with the unit quantities stated in the proposal as defined below. Prices for the following bid items shall include all labor, materials, tools, equipment, and other incidentals necessary to complete the work as shown on the plans and in accordance with these specifications.

A. **Bedding Stone, Granular:**

Measurement: Stone for bedding, when required, is considered incidental to the cost of the pipe.

Payment: Not a pay item.

B. **Building Connections/Service Laterals:**

Measurement: Measurement of building connections shall be made on a per service basis regardless of service pipe material or length.

Payment: Payment for service laterals shall be at the contract unit price bid, per service, for the sized indicated and shall include bedding, bends, wyes, saddles (if applicable), adapters, long sweep wyes, cleanout riser and plugs, concrete collar if applicable, and other incidentals as necessary, curb/gutter and sidewalk replacement (if necessary) complete in place as shown on **Standard Details 533.01** and **533.02.** Any temporary pumps required to by-pass sewer around work areas shall be provided at no additional cost.

C. **Bypass Pumping:**

Measurement: Unless otherwise shown in the proposal, bypass pumping is to be considered on a case by case basis specific to the project.

Payment: Not a pay item unless otherwise shown in the proposal.

D. **Carrier Pipes (Installed in either Steel Encasements or Tunnel Liners)**

Measurement: Measurement shall be along the centerline of the pipe.

Payment: Payment for carrier pipes will be made at the contract unit price bid per linear foot and shall include all necessary materials, tools, and equipment necessary to install the pipe. The unit price does not include the casing pipe (see the individual pay items and 1.3M *Encasement Pipe (bored)*, 1.3.N *Encasement Pipe (open cut)*, and 1.3.X *Tunneling*). The unit price shall include the cost of excavation, bedding, backfilling, cleanup, and testing.

E. **Combination Sewer Force Main Air Valve and Air Release Manhole**

Measurement: Measurement for combination air valve and air release manholes on force mains shall be on an each basis.

Payment: Payment for combination air valve and air release manholes shall be paid for at the contract unit price bid for combination air valve and air release manholes. The price shall include all labor, material, equipment, stone bedding, precast doghouse manhole, cast iron frame and cover, bedding, tap and saddle, valve, concrete grade rings (if applicable), grade adjustments to iron frame if necessary, and other incidentals and piping as necessary, complete in place as shown on **Standard Detail 534.06**.

F. **Concrete Encasement**

Measurement: Payment for furnishing concrete encasement will be at the unit price bid per cubic yard for the class of concrete stated in the proposal, such price to be paid in addition to that paid per foot of sewer main.

Payment: The unit prices stated in the proposal shall include the cost of additional depth of excavation, forming, the furnishing and placing of concrete, cofferdams, and laying of pipe line to grade but excluding the pipe itself, complete in place, including all labor, equipment, and material, necessary and all other work incidental to the complete installation of the concrete encasement in accordance with the specification and details shown on the plans. Payment will be made to neat lines of construction shown on the plans with no allowance being made for extra ditch width.

G. **Concrete – Miscellaneous Unformed:**

Measurement: Concrete, except that used in manholes, will be measured in cubic yards of unformed concrete actually placed. Typical uses include concrete collars (slope anchors), cradles, and all other miscellaneous concrete related to sewer line installation.

Payment: This item will be paid for at the contract unit price per cubic yard for un-formed concrete for collars, cradles, and all other miscellaneous concrete related to sewer line installation, in place, including all material, equipment, and labor, to place the concrete in the locations shown on the construction drawings and/or as directed by the Engineering Director including the cost of removing and disposing of the material replaced by the concrete. Payment will be made only for the quantities and dimensions (made to neat lines of construction) as shown on drawings or applicable details. Price does not include pipe.

H. **Concrete Piers**

Measurement: Reinforced concrete piers shall be measured on an each basis based on the height and the structural details shown on the contract drawings.

Payment: This item will be paid for at the contract unit price bid for concrete piers complete in place, including all labor, equipment, and material, necessary for furnishing, excavating, disposal of excess material, stone bedding, reinforcement,

anchor bolts, steel straps, concrete, testing, forming, concrete finishing, backfilling, restoration of grade, and all other work incidental to the complete installation of the concrete piers in accordance with the specification and details shown on the plans. Payment will be made to neat lines of construction shown on the plans with no allowance being made for extra ditch width.

I. **Connections to Other Sewers or to Appurtenances**

Measurement: Measurement shall be made on an each basis for connections made to other sanitary sewers and appurtenances.

Payment: Connections to other sewers or appurtenances shall be made on a lump sum basis and shall be full compensation for removing, repairing, and/or replacing pipe and/or structures and shall be full compensation for the completed work in place including all materials, labor, tools, and equipment.

J. **Detectable Warning Tape**

Measurement: See paragraph 1.2.G, Water.

Payment: See paragraph 1.2.G, Water.

K. **Directional Boring**

Measurement: See paragraph 1.2.H, Water.

Payment: See paragraph 1.2.H, Water.

L. **Ductile Iron Sewer Line**

Measurement: See pay item 1.3.T, Measurement of Sewer Pipe.

Payment: See pay item 1.3.T, Measurement of Sewer Pipe.

M. **Encasement Pipe (bored):**

Measurement: Steel casing pipe of the wall thickness and diameter specified will be measured by the linear feet of steel casing pipe installed.

Encasement of sewer mains by the dry bore and jacking method shall include any excavation, any backfill, the encasement pipe, bore, jacking, spiders, end seals, dewatering, clean up, restoration and any other work required for a complete in place installation.

Payment: Steel casing pipe will be paid for at the contract unit price bid per linear foot per diameter per thickness for steel casing pipe bored, complete and acceptable in place. Payment will only be made upon acceptance by the Town of Clayton and the Consulting Engineer that the bore is installed to the proper elevation and grade and ready for the installation of the designed carrier pipe without any additional compensation. Any deviations, errors, or unacceptable conditions noted by the Town of Clayton or the Johnston County office of the North Carolina Department of Transportation (if applicable) will be the responsibility of the Contractor to correct to

the satisfaction of the above-mentioned parties. Lines either off on grade or alignment shall be rejected or corrected in a manner approved by the Engineering Director. *Regardless of the number of withdrawal and reattempts, the bore shall be paid one time for a successful bore on a linear foot basis*. The cost of the carrier pipe is not to be included.

N. **Encasement Pipe (open cut):**

Measurement: Steel casing pipe of the wall thickness and diameter specified will be measured by the linear feet of steel casing pipe installed.

Encasement of sewer mains by the open cut method shall include any excavation, any backfill, the encasement pipe, spiders, the ends seals, dewatering, clean up, restoration and any other work required for a complete in place installation.

Payment: Steel casing pipe will be paid for at the contract unit price bid per linear foot per diameter per thickness for steel casing pipe installed by the pipe open cut, complete and in place. Lines off either on grade or alignment shall be rejected and corrected in a manner approved by the Engineering Director. The cost of the carrier pipe is not to be included.

O. **Excavation and Backfill:**

Measurement and Payment: All excavation and backfill shall be included in the cost of the other items bid – not a pay item.

When the removal of existing structures or materials is classified separately as a contract pay item, payment will be made in accordance with the contract price; otherwise, such work will be considered as incidental work and will not be paid for directly, but the cost shall be included in the unit price for other items of work. In either case, such price or prices shall be full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the work.

P. **Manholes – Standard and Drop:**

Measurement: Manholes shall be measured on an each basis for a basic 6-foot deep manhole inclusive of frame and cover and base. For all depths in excess of 6 feet, manholes shall be measured by the vertical foot of depth of the manhole constructed in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). For determining the additional depth of manhole to be paid for at the unit price bid per vertical foot, manholes shall be measured from the invert of the pipe outlet to the top of the manhole frame and cover and recorded to the nearest 1/10 of a foot.

Where more than one type or size (diameter) designation is shown on the drawings, or called for in the special provisions, a separate bid item of the following form shall cover each:

1) Type (or Size) Manhole, per each.
2) Depth of Manhole, per vertical foot.
3) Drop Manhole Connection, per vertical foot.

Payment: Manholes shall be paid for at the contract unit price bid for a 6-foot deep manhole on an each basis plus a unit price per vertical foot for all depths in excess of 6 feet deep in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). Price shall include furnishing and constructing manholes complete-in-place including excavation, connection to existing sewers if necessary (including inside drops where they occur), complete invert forming in accordance with the standards and drawings, rubber boots, bedding stone, furnishing and bolting castings to cone, gaskets, parging interior joints, vent pipe if required (see **Standard Detail 532.10**), grade adjustment and grade rings if applicable (see **Standard Detail C06.03**), flex-seal sealant at grade ring adjustments, exterior sealing system, vacuum testing, backfill and compaction complete in every detail. See **Standard Details 532.01, 532.02, 532.03,** and **532.07, 532.09**.

Q. **Manholes – Doghouse:**

Measurement: Manholes shall be measured on an each basis for a basic 6-foot deep manhole inclusive of frame and cover and a base constructed in accordance with **standard detail 532.05**. For all depths in excess of 6 feet, manholes shall be measured by the vertical foot of depth of the manhole constructed in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). For determining the additional depth of manhole to be paid for at the unit price bid per vertical foot, manholes shall be measured from the invert of the pipe outlet to the top of the manhole frame and cover and recorded to the nearest 1/10 of a foot.

Where more than one type or size (diameter) designation is shown on the drawings, or called for in the special provisions, a separate bid item of the following form shall cover each:

1) Type (or Size) Manhole, per each.
2) Depth of Manhole, per vertical foot.
3) Drop Manhole Connection, per vertical foot.

Payment: Doghouse manholes shall be paid for at the contract unit price bid for a 6 foot deep manhole on an each basis plus a unit price per vertical foot for all depths in excess of 6 feet deep, in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). Price shall include furnishing and constructing manholes complete-in-place including excavation, base construction, complete invert forming in accordance with the standards and drawings, rubber boots if applicable, bedding stone, inside drops where they occur, furnishing and bolting castings to cone if applicable, gaskets, parging interior joints, vent pipe if required (see **Standard Detail 532.10**), grade adjustment and grade rings, if applicable (see **Standard Detail C06.03**), flex-seal sealant at grade ring adjustments, exterior sealing system, vacuum testing, backfill and compaction complete in every detail. See **Standard Detail 532.05**.

R. **Manhole Frames and Covers – Standard and Watertight:**

Measurement and Payment: Not a pay item. The cost, setting, and final adjustment of the standard and watertight manhole frames and covers are covered under the cost of the manhole for the type manhole specified. See **Standard Details C06.01**, and **C06.02**.

S. **Manhole - Precast Concrete Riser Ring:**

Measurement and Payment: Not a pay item. The cost, setting, and final adjustment of manhole grade rings are covered under the cost of the manhole for the type of manhole specified. See **Standard Detail C06.03**.

T. **Measurement of Sewer Pipe**

Measurement: Sewer pipe shall be measured from center to center of manholes and depth of cut from invert to original ground line at centerline. No deductions in length will be made for branches and appurtenances along the line. For all depths in excess of 6 feet, sewer pipe shall be measured by the vertical foot of depth of the line constructed in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). The Contractor must determine the original ground line immediately prior to any trench excavation. It is the Contractor's responsibility to provide this information to the Town within 24 hours of the beginning of the trench excavation activities.

Payment: Sewer pipe shall be paid for at the contract unit price bid for a 6 foot deep line on a per linear foot basis plus a unit price per vertical foot for all depths in excess of 6 feet deep, in 2-foot increments (e.g. 0 to 6', 6.1' to 8.0', 8.1' to 10.0', etc.). Payment will be made at the contract unit price bid per linear foot as stated in the proposal for the type of pipe specified and shall include trench excavation (excluding rock and select fill), shoring or use of trench box, installation, pumping, backfilling, compaction, testing of failed trenches, disposal of excess material, pressure testing, and cleanup complete in place.

U. **PVC Sewer Line**

Measurement: See pay item 1.3.T, Measurement of Sewer Pipe.

Payment: See pay item 1.3.T, Measurement of Sewer Pipe.

V. **Pump Stations**

Measurement: Sanitary sewer lift stations shall be measured based on an each basis.

Payment: Sanitary sewer lift stations shall be paid for at the contract lump sum price bid based on the contract drawings. Payment shall cover complete installation including, but not necessarily limited to, auxiliary generator or Dri-Prime backup pump as applicable, emergency backup pump valved connection, valve vault, fencing and gates, odor control/water tank pad, wet well and valve vault, other valving necessary per design, pumps, non-freeze yard hydrant, graveled fenced enclosure, access road, shower and eye wash station, water service and meter, electrical service, disconnect, and meter, area light, control panel, manufacturers start up, witness and operational test, operational manuals, etc. complete in place.

W. **Testing:**

Not a pay item. The associated work, materials and labor involved in testing sewer mains and manholes is considered incidental to the cost of the sewer main construction and shall be included in other bid items.

X. **Tunneling:**

Measurement: Tunneling will be measured by the linear feet of tunnel installed.

The tunneling method shall include any and all excavation including disposal of excavated material, shoring and bracing, any backfill, steel liner plates and bolts, ventilation system for workers, lagging, spiders, grout plugs, sand-cement grouting of voids, steel drain pipe, French drain, concrete paved invert, the ends seals, dewatering, clean up, restoration and any other work required for a complete in place installation.

Payment: Tunneling will be paid for at the contract unit price per linear foot for diameter installed by the tunneling cut, complete and acceptable in place. Payment will only be made upon acceptance by the Town of Clayton and the Consulting Engineer that the tunnel is installed to the proper elevation and grade and ready for the installation of the designed carrier pipe without any additional compensation. Any deviations, errors, or unacceptable conditions noted by the Town of Clayton or the Jacksonville office of the North Carolina Department of Transportation (if applicable) will be the responsibility of the Contractor to correct to the satisfaction of the above-mentioned parties. Unit price does not include the carrier pipe.

Y. **Other:** Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.4 STORM DRAINAGE

A. **Catch Basins and Drop Inlets (Precast or Block):**

Measurement: Precast or block catch basins and drop inlets will be measured on an each basis for the specified size and depth shown on the plans.

Payment: Precast or block catch basins and drop inlets will be paid for at the contract unit price per each for the specified size and depth shown on the plans. Price shall include all labor, material, and equipment necessary for installation, pouring of concrete invert, cutting or sawing, concrete collars, stone, invert forming, iron castings, and mortaring of required components, etc., complete in place, and in accordance with the requirements of paragraphs 3.3 and 3.4 of 02630, *Storm Drainage*.

B. **Flared End Section:**

Measurement: Flared end section, will be measured on an each basis.

Payment: Flared end section will be paid for at the contract unit price per each of the size indicated on the drawings and shall include all equipment, labor, materials for installation, excavation, backfill, stone if required, sealing and mortaring, complete in place.

C. **Head/Endwalls:**

Measurement: Head/endwalls will be measured on an each basis.

Payment: Head/endwalls will be paid for at the contract unit price per each of the size and type indicated on the drawings and shall include all equipment, labor, materials for installation, excavation, weep holes, shoring removal and replacement, curing, finishing, backfill, sealing and mortaring, complete in place.

D. **Manholes - Standard:**

Measurement: Storm drainage manholes shall be measured on an each basis for the specified diameter and depth shown on the plans.

Payment: Standard manholes will be paid for at the contract unit price for the specified diameter and depth shown on the plans, complete in place. Price shall include excavation, bedding stone, complete invert pouring and forming of concrete in accordance with the standard details and drawings, iron castings, concrete grade rings (if required), gaskets, backfill, and compaction, etc.

E. **Manhole Frames and Covers – Standard:**

Measurement: Manhole frames and covers are considered incidental to the cost of the precast structure on which it will be placed.

Payment: Not a pay item.

F. **Manhole, Abandonment:**

Measurement: Manhole abandonment will be measured on an each basis.

Payment: Manhole abandonment will be paid for at the contract unit price per each, complete in place, in accordance with the requirements paragraph 3.6.B of *02530, Sanitary Sewer*.

G. **Rip Rap, Dry**:

Measurement: Dry rip rap will be measured by the square yard.

Payment: Dry rip rap will be paid for at the contract unit price per square yard of the size as indicated on the drawings and shall include all materials (including geotextile fabric), labor, and equipment necessary for a complete in place installation.

H. **Rip Rap, Grouted:**

Measurement: Grouted rip rap will be measured by the square yard.

Payment: Grouted rip rap will be paid for at the contract unit price per square yard of the size as indicated on the drawings, with the top 6 inches grouted, and shall include all materials (including geo-textile fabric), labor, and equipment necessary for a complete in place installation.

I. **Storm Pipe, Reinforced Concrete, CPP, & HDPE**:

Measurement: Storm pipe will be measured from the exact beginning of the pipe to the end of the pipe for the size and class pipe specified.

Payment: Storm pipe will be paid for at the contract unit price per linear foot for pipe of the wall thickness, class, and pipe size specified, complete in place. This price shall include pipe, trench excavation (excluding rock), stone bedding if specified, shoring or use of trench box, installation, pumping, joint compound, backfilling (excluding select fill), compaction, and disposal of excess material.

J. **Other**: Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.5 EARTHWORK

A. **Geotextile Separation/Soil Stabilization Fabric (NCDOT Type as specified in contract documents)**

Measurement: Geotextile Separation/Soil Stabilization Fabric placed over either an earthen or stone subgrade shall be field measured by the horizontal exposed surface of the fabric, complete in place, to the nearest the square yard. No compensation for overlaps or waste.

Payment: When a Geotextile Separation/Soil Stabilization fabric is directed to be placed by the Engineering Director, the geotextile shall be paid for at the contract unit price for separation/soil stabilization fabric by the square yard. Payment shall include all materials, laps, seaming, waste, placement, staking, and labor and equipment incidental to the placing of the separation/soil stabilization fabric placed per the manufacturers recommendations, and includes disposal of unused or waste material.

B. **Offsite Borrow:**

Measurement: Off-site borrow will be measured in its original position by cross sectioning the area excavated for borrow. The number of cubic yards will be computed from cross section measurements by the average end method. When it is impractical to measure the borrow, and if approved by the Engineering Director, truck tally measurements will be made in accordance with paragraph A of Section 3.11 – *Method of Volume Measurement*, 02200 - *Earthwork*.

Payment: Off-site borrow will be paid at the contract unit price per cubic yard for material placed, compacted, and complete in place, including all excavation, loading, hauling, erosion control of borrow source, placement, spreading and compaction of borrow material.

C. **Onsite Borrow:** Material obtained from the site by cut and fill areas or other areas onsite that are designated to be used as borrow material is not a pay item for material but payment will be made by regular excavation.

D. **Unclassified (Regular) Excavation:**

Measurement: Unclassified regular excavation will be measured in its original position by cross sectioning the excavation area. The number of cubic yards will be computed from cross section measurements by the average end method. When it is impractical to measure by cross-section method, other acceptable methods, involving three-dimensional measurements may be used if approved by the Engineering Director.

In cut sections, excavation of topsoil and root mat and material down to subgrade elevation or to a point of 1-foot below the top of existing natural grade or to the depth specified on the plans, whichever is greater, will be measured as regular excavation. When areas of unsuitable material are shown on the plans, excavation 1 foot below the elevation of such material shown on the plans will be measured as regular excavation.

In fill sections, excavation of topsoil and root mat and material down to subgrade elevation or to an elevation of 1-foot below the bottom of topsoil and root mat, whichever is greater, will be measured as regular excavation. When areas of unsuitable material are shown on the plans, excavation down to a point 1-foot below the elevations of such material shown on the plans will be measured as regular excavation.

Payment: Regular excavation will be paid at the contract unit price per cubic yard of excavation and shall include all labor, equipment, and material required, complete in place, including all excavation, loading, moving of cut and fill material, placement, spreading and compaction of material.

E. **Proof Rolling**: Not a pay item. Proof rolling is to be incidental to grading, base placement, and paving.

F. **Rock Excavation (other than trenches and pits):**

Measurement: Rock excavation will be measured by the Engineering Director or his representative in its original position, after which the rock shall be excavated to the depth specified by the Engineering Director and then measured by the cubic yard. Rock excavation shall consist of the removal and satisfactory disposal of all materials, which cannot be dislodged and excavated with modern, track-mounted, heavy-duty excavating equipment without drilling, blasting, or ripping. Rock is defined as material which cannot be effectively excavated during general grading with a D-8 or equivalent dozer drawing a new single-tooth ripper. Effective excavation is defined as the ability to remove 10 cubic yards or more of material after one hour of continuous ripping. Typical of materials classified as Rock in Open Excavation are boulders larger than 1-1/2 cubic yards or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

Payment: Rock excavation will be paid for at the contract unit price per cubic yard for rock excavation and shall include all labor, materials, insurance, all blasting, blasting plans, blast monitoring, post-blast reports, scaling and stabilizing rock cuts, mats, signage, traffic control, storage containers, and equipment to excavate and dispose of rock off site.

G. **Classified Excavation (Undercut):**

Measurement: The material shown on the plans as classified (undercut) excavation or determined by the Engineering Director to be unsuitable and designated as classified (undercut) excavation and not included in regular excavation will be measured by cross sectioning the undercut area. The number of cubic yards will be computed by average end method. When it is impractical to measure by cross-section method because of erratic locations of isolated deposits, other acceptable methods, involving 3-dimensional measurements may be used if approved by the Engineering Director.

Removal and satisfactory disposal of all unsuitable material located below subgrade elevation or 1-foot below the top of the existing natural grade, whichever is greater, 1-foot below the elevation of unsuitable material shown on the plans, or 1-foot below original ground in fill sections where topsoil and root mat are not required to be removed, will be measured as undercut excavation.

Payment: Classified (undercut) excavation will be paid for at the contract unit price per cubic yard for classified (undercut) excavation and shall include all labor, equipment, and material required, complete in place, including all excavation and disposal of material.

H. **Unclassified Excavation for Widening of Pavement:**

Measurement: Unclassified excavation for widening of pavement along existing paved areas and removal of existing paved areas will consist of the removal and satisfactory disposal of all materials except solid rock and concrete structures necessary for the construction of street widening projects including sidewalk and curb and gutter projects. Measured will be made by cross sectioning the widened area. The number of cubic yards will be computed by average end method. No payment for materials removed without authorization from the Engineering Director or beyond the lines and grades set by the Engineering Director.

Payment: Unclassified excavation for pavement widening will be paid for at the contract unit price per cubic yard for unclassified excavation for widening of pavement. The price shall include all labor, equipment, and materials, including sawing or cutting the existing pavement or concrete, excavation of and disposal of material, preparing the grade, etc., complete in place.

I. **Unclassified Excavation for Removal of Existing Concrete Structures:**

Measurement: Unclassified excavation for removal of existing concrete structures shall consist of the removal and satisfactory disposal of all materials in concrete structures that may be designated for removal by the Engineering Director or shown to be removed on plans. These structures shall include sidewalks, steps, retaining walls, concrete pavement, and other minor structures; measured by the cubic yard in terms of material removed from its original positions. No payment for materials removed without authorization from the Engineering Director or beyond the lines and grades set by the Engineering Director.

Payment: Unclassified excavation for removal of existing concrete structures will be paid for at the contract unit price per cubic yard for unclassified excavation for the type listed. The price shall include all labor, equipment, and materials necessary to remove

and dispose of, off site, any required structures, complete in place, including sawing or cutting the existing concrete if required.

J. **Other:** Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.6 BASE COURSE & PAVING

A. **Adjusting Manholes and Valves for Resurfacing:**

Measurement: Manhole and valve box adjusting will be measured on an each basis for the type of structure adjusted.

Payment: Manhole and valve box adjusting by the method of removing and adjusting the frame and cover. Manholes shall be adjusted as shown on **Standard Detail C06.03**. Manhole and valve box adjustments will be paid for at the contract unit price per each for adjusting manholes and valves, and shall include all labor, equipment, materials (inclusive of concrete grade rings for manholes), feathering asphalt to castings if necessary, etc. for a complete in place installation.

B. **Aggregate Base Course:**

Measurement: Aggregate base course will be measured by the ton (or square yards of the thickness as shown on the plans, only if approved by the Engineering Director). The quantity shall be determined on scales equipped with a dial and an automatic printer, all of which have been approved and sealed in accordance with Section 106-7, *Scales and Public Weighmaster,* NCDOT *Standard Specifications for Roads and Structures*, latest revision.

Payment: Aggregate base course will be paid at the contract unit price bid per ton for ABC (or square yards of a specified depth only if approved by the Engineering Director). Price shall include all material, equipment, and labor required to furnish and install the stone, complete in place and compacted.

C. **Asphalt Driveway – Removal & Disposal**

Measurement: Where an existing asphalt drive is encountered, as shown on the plans, pavement removal and disposal will be measured by the square yard regardless of the existing pavement material or depth.

Payment: This item will be paid for at the contract unit price per square yard for removal and disposal of asphalt drives. The unit price bid shall include all labor, tools, equipment, and material necessary to complete the work and shall include, but is not necessarily limited to, saw cutting the pavement, removal and disposal of all paving materials which are not suitable for backfill in the trench from the job, and compaction of the trench. There will be no extra payment for any of the above work, the cost of which shall be included in the unit price bid for removal and replacement of asphalt drives.

D. **Asphalt Concrete Pavement:**

[Alternate 1: By the SY]

Measurement: Asphalt concrete pavement shall be measured in square yards of the type specified as evidenced by area of asphalt installed. Measurement for all roadways will be based on plan quantities and field measurement, not tonnage tickets.

Payment: Asphalt concrete pavement will be paid for at the contract unit price bid per square yard for the type of asphalt concrete specified. This price shall be full compensation for asphalt concrete pavement, complete in place, including all materials, labor, tools, equipment, tack coat, maintenance of traffic, and all other incidentals necessary. Adjusting manholes, cleanouts, valve boxes, etc. will be paid separately at the bid price for each when adjusted by the Contractor. Payment will be made per square yard of surface covered. Core samples shall be taken by the Contractor in areas directed by the Town. The average depth of the asphalt will be determined from these samples. The unit price paid will be reduced proportionately for each 1/8 inch thickness below the specified thickness. Thicknesses less than 75% of that specified shall receive an additional overlay at the minimum depth recommended by NCDOT for the type of asphalt specified for this project as the surface course. No additional payment will be made for thicknesses greater than that designed

[Alternate 2: By the ton using Terminal Prices for adjustment]

Measurement: Asphalt concrete pavement shall be measured by the actual number of tons of plant mix competed and accepted on the job. Measurement for all roadways will be based on plan quantities and field measurements, verified by tonnage tickets unless otherwise directed by the Engineering Director.

Payment: Asphalt concrete pavement will be paid for at the “Contract Unit Price” bid per ton for the type of asphalt concrete specified. However, the “Contract Unit Price” per ton will be adjusted to account for variations either up or down in the price of asphalt binder from a “Base Price Index” to yield an “Adjusted Contract Unit Price.” The “Adjusted Contract Unit Price” is the price paid at the time the paving/work is placed or performed. The “Adjusted Contract Unit Price” shall be full compensation for asphalt concrete pavement, complete in place, including all materials, labor, tools, equipment, tack coat, maintenance of traffic, and all other incidentals necessary. Adjusting manholes, cleanouts, valve boxes, etc. will be paid separately at the bid price for each when adjusted by the Contractor. Payment will be made on a per ton basis.

PRICE ADJUSTMENT - ASPHALT BINDER FOR PLANT MIX:

When it is determined that the monthly selling price of asphalt binder on the first business day of the calendar month during which the last day of the partial payment period occurs varies either upward or downward from the “Base Price Index,” the “Contract Unit Price” for asphalt binder for plant mix will be adjusted.

The “Base Price Index” provided for asphalt binder for plant mix, per ton, shall be used to compute the “Adjusted Contract Unit Price.” The “Base Price Index” to be included in a proposal/contract along the applicable date will be the Monthly Price Index in effect 2 months prior the month in which the contract is let. The “Base Price Index” will

remain fixed throughout the life of the contract. This "Base Price Index" represents an average of F.O.B. selling prices of asphalt binder at supplier's terminals.

Price adjustments for asphalt binder for plant mix will be made in accordance with Section 620 of the NCDOT *Standard Specifications.*

[BIDDING NOTE: In preparation of the bid documents, the Town must indicate the "Base Price Index" for asphalt binder for plant mix per ton in the form of proposal. Along with this price, show the date of the selling prices of asphalt binder at supplier's terminal. The price and date is obtained from the DOT's website and then inserted into the bid documents.]

The following is a link to the NCDOT website showing the terminal price:

https://connect.ncdot.gov/projects/construction/lists/monthly%20terminal%20asphalt%20binder%20%20fuel%20fob%20prices/allitems.aspx

Core samples shall be taken by the Contractor in areas directed by the Town. The average depth of the asphalt will be determined from these samples. The unit price paid will be reduced proportionately for each 1/8 inch thickness below the specified thickness. Thicknesses less than 75% of that specified shall receive an additional overlay at the minimum depth recommended by NCDOT for the type of asphalt specified for this project as the surface course. No additional payment will be made for thicknesses greater than that designed

E. **Asphalt Concrete Paved Flumes, Walks, etc.:**

Measurement: Asphalt concrete paved flumes, walks, etc. will be measured in square yards for a depth of 4 inches.

Payment: Asphalt concrete paved flumes, walks, etc. will be paid for at the contract unit price bid in square yards for a depth of 4 inches and shall be installed in accordance with applicable NCDOT details and specifications, including all labor, equipment, and materials necessary for a complete in place installation.

F. **Asphalt Surface Treatment:**

Measurement: Per square yard of area covered.

Payment: Asphalt surface treatment will be paid per square yard of area covered. This price shall include all labor, equipment, and materials to furnish and install, complete in place.

G. **Foundation Stone:**

Measurement: Foundation stone for roadways will be measured by the cubic yard of foundation stone placed.

Payment: Foundation stone, if approved by the Engineering Director, will be paid for at the contract unit price for foundation stone by the cubic yard. Price shall include removal and disposal of unusable material and placement of stone, complete in place.

H. **Manhole and Valve Box Replacement for Resurfacing:**

Measurement: Manhole and valve box replacement will be measured on an each basis for the type of frame installed.

Payment: Manhole and valve box replacement for resurfacing will be paid on an each basis for the type of frame, lid and/or box installed at the contract unit price and shall include all labor, material, and equipment necessary to remove and install a new frame, complete in place.

I. **Pavement Removal, Replacement, Repair or Street Rehab:** This item shall cover pavement repair in areas where it becomes necessary to remove and replace the existing pavement in failed areas or areas where patching is required as part of roadway work or in locations as otherwise requested by the Engineering Director.

Measurement: Work and materials for pavement repair will be measured in the following manner.

1). **Unclassified excavation for pavement removal, replacement, repair or street rehab:** Where pavement is to be removed as shown on the plans, pavement removal, replacement, repair or street rehab will be measured in cubic yards of pavement, temporary maintenance stone, or other unclassified material removed, regardless of the existing pavement material or depth, and shall include disposal of material removed.

2). **Aggregate base stone for pavement repair** will be measured in square yards, generally 8 inches deep, but thickness shall be as shown on the plans or as directed by the Engineering Director.

3). **Asphalt base (B 25.0X) for pavement repair** (when specified) will be measured in square yards, generally 4 inches deep, but thickness shall be as shown on the plans or as directed by the Engineering Director.

4). **Asphalt surface (SF 9.5B) for pavement repair** will be measured in square yards generally 2” deep, but thickness shall be as shown on the plans or as directed by the Engineering Director.

5). **Surface treatment for surface treated pavement repair** will be measured in square yards.

6). **Temporary pavement repair** will be measured in terms of square yards consisting of a combination of material as defined in these specifications.

Payment: Work and materials for pavement repair will be paid for in the following manner.

1). **Unclassified excavation for pavement removal, replacement/repair and disposal** will be paid for at the contract unit bid price per cubic yard. The unit price bid shall include all labor, tools, equipment, and material necessary to complete the work and shall include, but is not necessarily limited to, saw cutting the pavement, removal of existing pavement materials which are not suitable for backfilling the trench from the job, disposal, placement of suitable

backfill material, and the cost for compaction and compaction testing by a certified and approved laboratory. This price shall include all work and grading to prepare the surface for paving, complete in place. In the case of pavement cut and removal, such price or prices shall include the cost of the required permit for cutting pavement, unless permit fees are included as a bid item in the Contract Documents. Extra width will not be measured for payment and there will be no extra payment for any of the above work, the cost of which shall be included in the unit price bid for pavement removal and replacement.

2). **Aggregate base stone for pavement repair** will be paid for at the contract unit price bid per square yard generally 8 inches deep, but thickness shall be installed according to the plans for ABC. This price shall include all labor, equipment, and material necessary to furnish and install the stone, complete in place.

3). **Asphalt base (B 25.0X) for pavement repair** will be paid for at the contract unit price bid per square yard (generally 4 inches deep) for the type of base mix as shown on the plans or as directed by the Engineering Director. This price shall include all labor, materials, and equipment, including tack, necessary to furnish and install the asphalt, complete in place. Payment will be made per square yard of surface covered.

4). **Asphalt surface (SF 9.5B) for pavement repair** will be paid for at the contract unit price bid per square yard for a particular thickness and type as shown on the plans or as directed by the Engineering Director. This price shall include all labor, materials, and equipment, including tack, necessary to furnish and install the asphalt, complete in place. Payment will be made per square yard of surface covered.

5). **Surface treatment for surface treated pavement repair** will be paid for at the contract unit price bid per square yard for surface treatment for pavement repair. This price shall be full compensation for one prime coat and two seal coats, complete in place.

6). **Temporary pavement repair** will be paid for at the contract unit price bid per square yard for temporary pavement repair. This price shall include aggregate stone to the depth specified on the plans, seal coat, and cold patch, as defined in these specifications and all labor, materials and equipment necessary, complete in place.

J. **Pavement Profiling - Milling:**

Measurement: Pavement profiling will be measured in square yards for each 1 inch depth of material profiled and removed.

Payment: Pavement profiling will be paid for at the contract unit price bid per square yards per 1 inch depth and shall include all labor, materials, and equipment necessary to remove and dispose of the material, complete in place.

K. **Petro-mat, or approved equal:**

Measurement: Petro-mat, or approved equal, will be measured in square yards based on surface measurements of area covered.

Payment: Mat will be paid for at the contract unit price bid in square yards for the type of material specified in these specifications and shall include all labor, equipment, and materials necessary for a complete in place installation.

L. **Portland Cement Treated Aggregate:**

Measurement: Portland cement treated aggregate will be measured in square yards of material with thickness as shown on the plans or as directed by the Engineering Director.

Payment: Portland cement treated aggregate will be paid at the contract unit price bid for square yards with thickness as shown on the plans or as directed by the Engineering Director. This price shall include all material, equipment, and labor required to furnish and install the Portland cement treated aggregate, complete in place.

M. **Prime Coat** (when specified by Engineering Director):

Measurement: Liquid asphalt material will be measured by the gallon.

Payment: Liquid asphalt material will be paid for at the contract unit price bid per gallon. This price shall include all labor, equipment, and materials to furnish, install, and maintenance of the treatment until surface course is applied, complete in place.

N. **Proof Rolling**: Not a pay item. Proof rolling is to be incidental to grading, base placement, and paving.

O. **Tack Coat: (Not a pay item, incidental to other items bid)**

P. **Other:** Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.7 CURB & GUTTER, DRIVEWAYS, SIDEWALKS, AND MISCELLANEOUS CONCRETE ITEMS

A. **New Concrete Sidewalk, 4 inches thick:**

Measurement: New sidewalk shall be measured per square yard of finished concrete at the width and depth specified in the contract.

Payment: New sidewalk shall be paid for at the contract unit price bid per square yard of finished concrete. This price shall include all labor, equipment, and material for excavation, backfilling, expansion joint material, formwork, finishing, curing, etc. for a complete in place installation, as shown on **Standard Detail 404.03** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

B. **Replacement of Concrete Sidewalk:**

Measurement: Replacement of sidewalk will be measured per linear foot of finished concrete.

Payment: Replacement of sidewalk will be paid for at the contract unit price bid per linear foot at a depth specified in the contract. This price shall include all labor, equipment, and material for excavation, removal and disposal of existing sidewalk, backfilling, expansion joint material, formwork, finishing, curing, etc. for a complete in place installation as shown on **Standard Detail 404.03** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

C. **New Concrete Driveways and Entrances:**

Measurement: New concrete driveways and entrances per design thickness will be measured in square yards of finished concrete.

Driveways formed in conjunction with standard curb, and curb and gutter, shall be measured in square yards as follows:

1) In length as shown on **Standard Details 404.01 and 404.02** as applicable.

2) In width from the back edge of the driveway to the back edge of the curb extended.

Payment: New concrete driveways and entrances will be paid for at the contract unit price bid per square yard at a depth as specified in the design. This price shall include all labor, equipment, and material for excavation, backfilling, expansion material, formwork, finishing, curing, etc. for a complete in place installation, as shown on **Standard Details 404.01** and **404.02** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

D. **Replacement of Concrete Driveways and Entrances:**

Measurement: Replacement of concrete driveways and entrances will be measured in square yards of finished concrete.

Driveways formed in conjunction with standard curb, and curb and gutter, shall be measured in square yards as follows:

1) In length as shown on **Standard Details 404.01** and **404.02** as applicable.

2) In width from the back edge of the driveway to the back edge of the curb extended.

Payment: Replacement of concrete driveways and entrances will be paid for at the contract unit price bid per square yard at depth as specified in the design. This price shall include all labor, equipment, and material for excavation, removal and disposal of existing concrete, backfilling, expansion material, formwork, finishing, curing, etc. for a complete in place installation as shown on **Standard Details 404.01 and 404.02** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

E. **New Concrete Curb and Gutter:**

Measurement: Standard 30” concrete curb and gutter, 30” roll-type curb and gutter, or 18” median curb, as specified and shown on the contract documents and on **Standard Detail 402.01,** will be measured per linear foot along the face or back of the curb for the entire length of the work including portion of curb shaped for handicap ramps and through driveways for the type curb and gutter installed.

Payment: Standard 30” concrete curb and gutter, 30” roll-type curb and gutter, or 18” median curb, as specified and shown on the contract documents and on **Standard Detail 402.01,** will be paid for at the contract unit price per linear foot and shall include all labor, equipment, and material for excavation, formwork, stone bedding, backfilling, expansion material, finishing, curing, etc. for a complete in place installation as shown on the **Standard Detail 402.01** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

F. **Replacement of Concrete Curb and Gutter:**

Measurement: Replacement of concrete curb and gutter, roll-type curb and gutter, or median curb with new standard 30” concrete curb and gutter, 30” roll-type curb and gutter, or 18” median curb will be measured per linear foot along the face or back of the curb for the entire length of the work including portion of curb shaped for handicap ramps and through driveways for the type of curb and gutter installed.

Payment: Replacement of concrete curb and gutter, roll-type curb and gutter, or median curb with new standard 30’ concrete curb and gutter, 30” roll-type curb and gutter, or 18” median curb will be paid for at the contract unit price bid per linear foot. This price shall include all labor, equipment, and material for excavation, removal and disposal of existing concrete, backfilling, stone bedding, expansion material, formwork, finishing, curing, etc. for a complete in place installation as shown on **Standard Detail 402.01** and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

G. **Vertical Concrete Curb:**

Measurement: Vertical concrete curb will be measured in linear feet along the face of the curb including handicap ramps and driveway openings.

Payment: Vertical concrete curb will be paid in linear foot the contract unit price for 6”X12” curb. Prices shall include all labor, equipment, and material for excavation, formwork, stone bedding, backfilling, expansion joint material, finishing, curing, etc. for a complete in place installation and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

H. **Concrete (Handicap) Curb Ramp:**

Measurement: Concrete handicap curb ramps will be measured on a per ramp basis based on the pay limits shown on the applicable curb ramp Standard Detail(s).

Payment: Concrete handicap curb ramps will be paid for based on the pay limits shown (shaded) on the applicable curb ramp Standard Detail at the contract unit price bid per ramp. This price shall include all labor, equipment, and material for excavation, removal and disposal of existing concrete, backfilling, stone bedding, expansion

material, formwork, finishing, detectable warning surface, curing, etc. for a complete in place installation as shown on the standard details and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director.

I. **Formed Concrete for Retaining Walls, Piers, Steps, and other misc. Concrete Structures:**

Measurement: Formed concrete for retaining walls, piers, steps, and other misc. concrete structures will be measured by the cubic yard of concrete placed excluding waste. Reinforcing steel shall be paid for by the pound.

Payment: Formed concrete for retaining walls, piers, steps, and other misc. concrete structures will be paid for at the contract unit price bid per cubic yard of concrete placed. Price shall include excavation, foundation preparation, foundation stone if required, steel placement, chairs, tying, forming, stripping forms and disposal, concrete finishing/rubbing/patching, backfilling and compaction, and dress-up. Reinforcing steel will be paid for separately by the pound of steel placed in accordance with the quantities required on the drawings or applicable details. No payment for waste and disposal of reinforcing steel. Payment will be made only for the quantities associated with the design drawings or applicable details.

J. **Concrete Paved Ditches:**

Measurement: Concrete paved ditches will be measured per square yard of paved ditch based on measurements as defined on the applicable details or construction drawings, at the thickness specified

Payment: Concrete paved ditches will be paid for at the contract unit price per square yard and shall include all labor, equipment, and material for excavation, formwork, stone bedding, backfilling, expansion material, finishing, curing, etc. for a complete in place installation and installed at the locations as shown on the construction drawings and/or as directed by the Engineering Director, at the thickness specified.

K. **Tree Well in Sidewalk :**

Measurement: Tree wells will be measured on an each basis.

Payment: Tree wells will be paid for at the contract unit price per each and shall include all labor, equipment, and materials to install the tree well, complete in place.

L. **Wheel Bumpers, Concrete:**

Measurement: Concrete wheel bumpers will be measured on an each basis.

Payment: Concrete wheel bumpers will be paid for at the contract unit price per each and shall include all labor, equipment, and materials to install the wheel block, complete in place.

M. **Other**: Other items shall be paid for as provided under *Section 1.8, Items Miscellaneous to All Sections* or as stated in the Proposal.

1.8 ITEMS MISCELLANEOUS TO ALL SECTIONS

A. **Clearing and Grubbing Wooded Areas:**

Measurement: Measurement for clearing and grubbing will be by the acre. The disturbance shall not exceed width as defined in the construction limits criteria.

Payment: Price per acre for clearing and grubbing in wooded areas shall include all material, equipment, and labor required to clear and grub wooded areas in accordance with these specifications. The price shall also include the removal and disposal of items.

B. **Construction Entrance**

Measurement: Construction entrance for erosion control will be measured on an each basis. Size and depth of stone shall be based on the dimensions, type and depth of stone as specified in the NCDEQ, Division of Energy, Mineral, and Land Resources, Erosion and Sedimentation Control Section, *Erosion and Sediment Control Planning and Design Manual*, latest revision.

Payment: Construction entrance for erosion control will be paid for at the contract unit price per each and shall include all materials, stone, including Geotextile fabric, labor, and equipment necessary for a complete in place installation as well as maintenance.

C. **Flowable Fill Concrete:**

Measurement: Measurement shall be by the cubic yard of concrete placed, regardless of the specified strength.

Payment: Paid for in place by the cubic yard.

D. **Hand/Guard Rails for Retaining Walls and Head/Endwalls, Sidewalk, Etc.:**

Measurement: Measurement of hand/guard rails shall be by the linear foot of completed rail.

Payment: Payment for hand/guard rails is to include furnishing all labor, materials, equipment, and fabrication for a complete installation of hand/guard rails that conforming to the requirements of the contract documents. Payment shall include, but is not necessarily limited to construction staking, post footing excavation, placement of concrete footing (concrete for posts in SRW's excluded), field touch-up, pipe sleeves for bases, etc.

E. **Hydroseeding:**

Measurement: Measurement of hydroseeding is to be to the nearest ¼ acre as approved and accepted by the Engineering Director and shall include all equipment, materials, management, and labor necessary to prepare a seed bed, apply the mix of seed mix, fertilizer, and mulch evenly immediately after the seedbed has been prepared. Seedbed preparation is to be incidental to the cost of hydroseeding.

Payment: Payment will be made at the contract unit price for general hydroseeding to the nearest ¼ acre approved and accepted.

F. **Quality Control Testing Costs**: Unless otherwise indicated or stipulated in the contract documents, the costs for Quality Control Testing is not a pay item. The cost of Quality Control (QC) tests, as prescribed in the applicable specification section(s), tests to assure the Contractor that he/she is meeting and complying with the requirements of the applicable specification section, is the Contractor's responsibility. The cost of Quality Assurance (QA) tests, tests performed independently by the Town of Clayton to confirm that the Contractor is generally performing his/her work in compliance with these specifications, is the responsibility of the Town of Clayton.

G. **Segmental Retaining Walls (SRW) for Retaining Wall and Head/Endwalls:**

Measurement: Measurement of SRW's shall be by the square foot of completed wall surface area (i.e. wall length times the wall height. Wall height to be measured from the top of the footing to the top of the wall [top of cap unit].).

Payment: Payment for SRW's includes furnishing all labor, materials, equipment, for a complete SRW all in accordance with the contract documents. Payment shall include, but is not necessarily limited to, footing excavation, construction staking, furnishing and placing stone or concrete footing (as shown on construction drawings), sawing and cutting of SRW units and caps as required for wall and pipe penetrations/collars, concrete fill and steel reinforcement (if required) for hand/guard rails, anchor pins, gluing cap units, unit stone fill if required, placement of geotextile reinforcing fabric, placement of granular drainage (with or without drainage filter fabric), drainage pipe, select backfill as specified on construction drawings, compaction, density tests for quality control, clay cap if required, grading/shaping of finished grade, disposal of all excess material and waste. Hand/guard rails and landscaping to be paid under a separate pay item.

H. **Silt Fence Barrier:**

Measurement: Silt fence barrier for erosion control will be measured by the linear foot.

Payment: Silt fence barrier for erosion control will be paid for at the contract unit price per linear foot and shall include all material, labor, and equipment necessary for a complete in place installation. The price shall also include the removal, maintenance, and disposal of silt fence upon stabilization of ground cover.

I. **Sodding, Fertilizing, Seeding and Fine Grading:**

Measurement: Measurement of surfaces to be sodded or seeded shall be measured to the nearest square yard for the class specified. Sodding, fertilizing, seeding, and fine grading shall be provided as described section in 02920, *Seeding, Sodding, and Groundcover*. Extra compensation will not be made for additional seeding beyond all limits of construction as defined in applicable section.

Payment: Payment for sodding, fertilizing, seeding, and fine grading will be at the contract unit price square yard for sodding, fertilizing, seeding, and fine grading as described in 02920, *Seeding, Sodding, and Groundcover*. No compensation will be

made for reseeding, if required. The cost of restoring areas located beyond the designated area(s) shall be borne by the Contractor.

J. **Temporary Access or Haul Roads**

Measurement: Any grading or excavation required for equipment travel during the course of construction as well as erosion control, removal, restoration, seeding and ground cover shall be included in other items bid.

Payment: Included in other items bid. Not a pay item.

K. **Traffic Control**:

Not a pay item. The associated work, materials, and labor involved in traffic control are incidental to the cost of construction and shall be included in other bid items. However, some special projects may require that the contractor provide a unit price bid to cover traffic control. In this case, traffic control will be measured and paid for on a lump sum basis as separate pay item, and shall include all elements required to provide complete traffic control for the project. Traffic control shall include, but may not necessarily be limited to, barricades, portable electronic road signs, flagging, flagmen, detours and detour signing, barriers, signs, cones, temporary striping, etc.

END OF SECTION 00950

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02200 – EARTHWORK

(Last revised 9/14/2024)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

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Part 2 – Products
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Cleanup
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Dust Control
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Subgrade Preparation
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PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to the furnishing, installing, and completing all operations associated with earthwork as shown on the approved construction drawings and standard details and in accordance with provisions of these specifications and the Contract Documents.

Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for earthwork, coordinated with the work of all related trades.

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General Requirements and Supplementary Conditions applicable to this specification.

B. The following operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

1) Section 02275 – Trenching, Backfilling, and Compaction of Utilities

2) Section 02510 – Water Distribution

3) Section 02530 – Sanitary Sewer

4) Section 02630 – Storm Drainage

5) Section 02920 - Seeding, sodding, and Groundcover

6) NCDEQ, Division of Energy, Mineral, and Land Resources, *Erosion and Sediment Control Planning and Design Manual, latest revision*.

7) US Department of Labor, Occupational Safety and Health Administration (OSHA), Standard *29 CFR Part 1926, Safety and Health Regulation for Construction, Subpart P "Excavations,"* latest edition.

American Society for Testing and Materials (ASTM)

1) **ASTM C33:** *Standard Specification for Concrete Aggregates*

2) **ASTM C136**: *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*

3) **ASTM D422**: *Standard Test Method for Particle-Size Analysis of Soils (for classification purposes only)*

4) **ASTM D698:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (Standard Proctor)*

5) **ASTM D1556:** *Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method*

6) **ASTM D1557:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (Modified Proctor)*

7) **ASTM D1883**: Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils

8) **ASTM D2049**: Standard Method of Test for Relative Density of Cohesionless Soils

9) **ASTM D2167:** *Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method*

10) **ASTM D2487:** *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

11) **ASTM D2922**: *Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)*

12) **ASTM D2937**: *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*

13) **ASTM D3740**: *Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*

14) **ASTM D4253**: *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*

15) **ASTM D4254**: *Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*

16) **ASTM D4318**: *Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.*

17) **ASTM D7382**: Standard Test Methods for Determination of Maximum Dry Unit Weight of Granular Soils Using a Vibrating Hammer

18) **ASTM E329**: *Standard Specification for Agencies Engaged in Construction Inspection and/or Testing*

19) **ASTM E548**: *Standard Guide for General Criteria Used for Evaluating Laboratory Competence*

American Association of State Highway & Transportation Officials

20) **AASHTO M145:** *Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*

21) **AASHTO T99**: *Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.)*

22) **AASHTO T180**: *Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop*

23) **AASHTO T191**: *Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method*

24) **AASHTO T204**: Density of Soil In-Place by the Drive Cylinder Method

25) **AASHTO T205**: *Standard Method of Test for Density of Soil In-Place by the Rubber-Balloon Method*

1.3 SUMMARY

A. This section includes:

1) Site clearing and grubbing

2) Stripping and stockpiling topsoil

3) Excavation and embankment placement

4) Preparing subgrade for pavements, walks, curb & gutter, and turfed areas

B. Construction and materials related to this section but covered elsewhere:

1) Erosion Control: North Carolina Sediment Control Law

1.4 DEFINITIONS

For the purposes of this specification, the following definitions refer to earthwork that comes under the authority of the Town of Clayton as specified within this division and other divisions of this manual.

A. **Borrow**: Borrow shall consist of approved fill material (approved by Geotechnical Engineer) imported from off-site.

B. **Clearing**: Clearing shall consist in the felling, cutting up, and satisfactory disposal of trees and other vegetation designated for removal in accordance with these specifications.

C. **Competent Person**: Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

D. **Engineering Director**: The Town's Director of Engineering or his or her authorized representative.

E. **Fill (in terms of volume)**: In terms of volume, fill is defined as a compacted post-construction volume in-place.

F. **Grubbing**: Grubbing shall consist of the removal of roots 1 ½ inch and larger, organic matter, debris, and stumps and the disposal thereof.

G. **Classified Excavation (undercut)**: Classified excavation shall consist of the removal and satisfactory disposal of all unsuitable material located below subgrade elevation. Where excavation to the finished grade section results in a subgrade or slopes of muck, peat, matted roots, etc., the Contractor shall remove such material below the grade shown on the plans or as directed; and areas so excavated shall be backfilled with approved select fill or stone as ordered by the Engineering Director. See also paragraph P, Unclassified Excavation.

H. **Plans**: The approved plans, profiles, typical roadway and/or cross-sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

I. **Rock in Open Excavation**: All boulder, solid ledges, bedded deposits, unstratified masses, and conglomerations of material so firmly cemented as to possess the characteristics of solid rock. Rock in open excavations includes removal and disposal on-site of materials and obstructions encountered in general excavation other than trenches and pits that cannot be dislodged and excavated with modern, track-mounted, heavy-duty excavating equipment without drilling, blasting, or ripping. Rock is defined as material which cannot be effectively excavated during general grading with a D-8 or equivalent dozer drawing a new single-tooth ripper. Effective excavation is defined as the ability to remove 10 cubic yards or more of material after one hour of continuous ripping. Typical materials classified as Rock in Open Excavation are boulders larger than 1-1/2 cubic yards or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

J. **Rock Excavation for Trenches and Pits**: Rock excavation for trenches and pits includes removal and disposal off-site of materials and obstructions encountered

that cannot be practically excavated with a track-mounted power excavator, equivalent to a Caterpillar Model No. 325 or equivalent equipped with a new rock teeth. Practical excavation is defined as the ability to remove at least 30 cubic yards during one hour of continuous digging. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.

K. **Select Fill Material**: Nonplastic material, free of organic material, used as foundation for subbase, shoulder surfacing, fill, backfill, or other specific purposes.

L. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

M. **Structures**: Incidental buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

N. **Subgrade**: Surface or elevation remaining after completing the excavation, or top surface of a fill or backfill immediately below pavement structure, concrete or topsoil materials, as applicable.

O. **Topsoil**: See Section 02920 – *Seeding, Sodding, and Groundcover*.

P. **Unclassified Excavation**: Removal and disposal of any and all material above subgrade elevation or within the 12 inches of existing natural grade, whichever is greater, except solid rock and undercut excavation, located within the limits of construction.

Q. The following are standard abbreviations for various industries, agencies, and documents:

1) **AASHTO**: American Association of State Highway & Transportation Officials

2) **ANSI**: American National Standards Institute

3) **AREA**: American Railway Engineers Association

4) **AREMA**: The American Railway Engineering and Maintenance of Way Association

5) **ASTM**: American Society for Testing and Materials

6) **DEMLR**: NCDEQ Division of Energy, Mineral and Land Resources, (Land Quality Section)

7) **DWR**: NCDEQ, Division of Water Resources

8) **E&SC**: Erosion & Sedimentation Control

9) **EPA**: Environmental Protection Agency

10) **MSDS**: Material Safety Data Sheets

11) **MUTCD**: Manual on Uniform Traffic Control Devices

12) **NCDEQ**: North Carolina Department of Environmental Quality

13) **NCDOT**: North Carolina Department of Transportation

14) **NPDES**: National Pollutant Discharge Elimination System

15) **OSHA**: Occupational Safety and Health Administration

16) **UL**: Underwriters Laboratories, Inc

17) **USACOE**: United States Army Corps of Engineers

1.5 SUBMITTALS

A. Submit product data and a sample of separation fabric and fully document each with specific location or stationing information, date and other pertinent information.

B. **Material Test Reports**: Provide from a qualified testing agency test results and interpretation for compliance of the following requirements indicated:

1) Classification according to ASTM D2487 of each on-site or borrow soil proposed for backfill, unless otherwise directed by the Engineering Director.

2) Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for fill or backfill.

3) Laboratory compaction curve according to ASTM D1557 for each on-site borrow soil material proposed for fill and backfill.

C. **Blasting**:

1) Insurance Certificate naming the Town of Clayton as “Additional Insured.” See paragraph 3.4 Rock for other blasting insurance requirements.

2) Qualifications, proposed procedures, and schedule shall be submitted at least 2 weeks prior to commencing any blasting operations.

3) Permits from Town and local Fire Department and Town officials. Coordinate with Town of Clayton Deputy Chief/Fire Marshall.

4) Blasters shall, at all times, have their license and blasting permits on the job site, and shall allow examination of same by any official that may have jurisdiction.

5) If required by the Engineering Director, seismic survey agency report, for record purposes.

6) : Depending on the proximity of existing structures to the proposed blast site, the Town of Clayton Engineering Director may recommend that the contractor perform a Pre-Blast and Post-Blast Conditions survey of nearby structures as well as provide vibration/noise monitoring during blasting.

7) Pre-Blast & Post-Blast Survey Conditions Survey May Be Required: A pre-blast "existing conditions" survey may be required by the Town as part of the blasting permit to establish the pre-existing condition of structures (Residences, commercial properties, etc.) in close proximity to the blast site. The Engineering Director may require the pre-blast/post-blast surveys be performed by a Structural Engineer (a NC Licensed Professional Engineer). Coordinate with the Fire Marshall as well.

The Engineering Director or Fire Marshall may also request vibration/noise monitoring during blasting.

Contractor to maintain documentation on the existing conditions and post-construction conditions survey and provide to the Engineering Director upon request.

D. **Product Data**:

1) Stabilization/Separation fabric

1.6 QUALITY ASSURANCE

A. **Geotechnical Testing Agency Qualifications**: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing as documented according to ASTM D3740 and ASTM E548. Testing Lab to be AMRL (AASHTO Materials Reference Laboratory) and CCRL (Cement and Concrete Reference Laboratory) certified.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

C. The contractor shall comply with North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, "*Erosion and Sediment Control Planning and Design Manual*," latest revisions.

D. Comply with applicable requirements of NFPA 495, *"Explosive Materials Code."*

1.7 TESTING SERVICES

A. The Testing Laboratory shall be approved by the Engineering Director and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation.

B. Specific test and inspection requirements shall be as specified herein.

1.8 PROJECT CONDITIONS

A. **Demolition**: Demolish and completely remove from the site existing utilities, structures or surface features indicated on the plans to be removed. Coordinate with applicable utility companies to shut off services if lines are active.

B. **Burn Permits**: For open burning within the Town of Clayton's Town Limits, secure a burning permit from the Town of Clayton Fire Department. Coordinate with Deputy Chief/Fire Marshall. If burning outside the Town Limits, secure permit from NC Forest Service and/or local Fire Department, as applicable. Observe NC Forest Service Code Orange and Code Red burn bans as applicable.

C. **Environmental - Wetlands**: Before crossing or entering into any jurisdictional wetlands, Contractor shall verify whether or not a wetlands permit has been obtained for the encroachment and whether special restrictions have been imposed. Care shall be taken to prevent draining or otherwise destroying non-permitted wetlands. Restore as stated on either the project drawings, the contract documents, and/or as noted in the permit. All crossings, disturbance, and encroachments into wetlands shall be subject to USACOE and NCDEQ Division of Water Resources approval and permitting requirements and conditions.

D. **Environmental - Buffer Crossing Requirements**: Before crossing streams or ditches or working within 50 feet of ponds, lakes, or rivers, the Contractor shall verify whether the project is exempt or if a permit has been obtained to encroach into such buffers or other such regulated waters, and to what extent work is permitted to occur. Unless otherwise permitted, shown on the contract drawings, or exempted by NCDEQ, roadways crossing stream, river, pond, or lake buffers are to be as near perpendicular as possible (the crossing is considered to be perpendicular if it intersects the stream or surface water between an angle of 75 and 105 degrees). Do not disturb more than 40 linear feet (longitudinal) of riparian buffer without approval from NCDEQ. When permitted to encroach into zone one of a buffer (the lower 30 feet beside the stream or water), adhere to the following Best Management Practices, as well as any that may be listed on an approved permit:

1) Woody vegetation is cleared by hand. No grading allowed.
2) Stumps to remain except in trench where trees are cut. Minimize disturbance to roots in buffer zone.
3) Set aside topsoil and replace to existing grade immediately after backfilling.
4) Backfill trench with the excavated soil immediately following installation.
5) Do not use fertilizer except for the one-time application to reestablish vegetation.
6) Minimize removal of woody vegetation, the amount of disturbed area, and the time the disturbed area remains disturbed.
7) Take measures to ensure diffuse flow of water through the buffer after construction.
8) In wetland areas, use crane mats to minimize soil disturbance.
9) Remove the existing topsoil to a depth of 6 inches or to the depth encountered from all areas in which excavation will occur. The topsoil shall either be stored in stockpiles separate from the mass excavation if the topsoil is to be respread or otherwise disposed of off-site. Topsoil stockpiles shall be graded to freely

drain surface water and shall have a silt fence placed around the base of the stockpile.

E. **Safety**

1) The Contractor shall keep the surface over and along the roadways and other excavation in a safe and satisfactory condition during the progress of the work.

2) **Excavation Safety**: All excavations and slopes should be made and maintained in accordance with OSHA Excavation Safety Standards. The contractor is solely responsible for designing and constructing stable, temporary excavations and slopes and should shore, slope or bench the sides of the excavations and slopes as required to maintain stability of the excavation sides and bottom. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. The Town of Clayton is not assuming responsibility for construction site safety nor for the Contractors activities; such responsibility is not being implied and should not be inferred.

F. **Geotechnical Investigation**

1) Where a Geotechnical report has been provided to the Contractor by the Town of Clayton, the data on sub-surface soil conditions is not intended as a representation or warranty of the continuity of such conditions between borings or indicated sampling locations. It shall be expressly understood that the Town of Clayton will not be responsible for any interpretations or conclusions drawn there from by the Contractor. The data is made available for the convenience of the Contractor.

2) In addition to any report that may be made available to the Contractor, the Contractor is responsible for performing any other soil investigations felt necessary for proper evaluation of the site for the purposes of planning and/or bidding the project, at no additional cost to the Town of Clayton.

G. **Protection of pavement**

Debris from the site shall be removed in such a manner as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, dust, and debris at all times.

1.9 SERVICE INTERRUPTION

Contact the Town of Clayton to coordinate interruption of water, sewer, or gas service, operation of valves, line cut-ins, or placement of a tapping sleeve and valve, or need/use of public potable water. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Engineering Director, temporary service may be required to be provided. Provide a minimum of 72 hours' notice of the proposed utility interruption or necessary operation of valves.

1.10 COORDINATION

A. Except as needed for fire suppression purposes, the Town of Clayton will be the sole operator of all valves and hydrants on the Town's water distribution system. Adequate notifications to water customers will be given by the Contractor prior to any planned interruption of service. Service is to be continuously maintained to customers in the project areas except for the minimum amount of time required to make connections with the existing system. Only in the case of an emergency may a valve be closed by a Contractor. Records shall be kept of any valves closed during an emergency and the Engineering Director shall be notified of the specific valves closed at the earliest reasonable time following such valve closure.

   Before planned shut off any water main, residents are to be notified by the Town of Clayton's representative in writing at least 24 hours in advance of cut off. The Contractor shall provide assistance to the Town in notification distribution. The Town shall be notified at least 48 hours in advance of request for operation of valves and making either a wet tap or cut in.

B. Coordinate tie-ins to municipal roadway system with the Town of Clayton.

C. At the direction of the Engineering Director, for work impacting sanitary sewer mains/interruption of flow, temporary bypass pumping of sewerage flow may be required to be provided. See Section 02530 – Sanitary Sewer for bypass pumping requirements and procedures.

D. **Traffic Signal Detection Systems**: When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks' notice prior to anticipated disturbance or interruption. At the discretion of the Engineering Director, the notice may be required to be published in the newspaper.

E. **Repair of pavement markings**: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.

F. **Benchmark/Monument Protection**: Protect and maintain benchmarks, monuments or other established reference points and property corners. If disturbed or destroyed, they must be replaced at own expense by a Licensed Professional Surveyor to full satisfaction of Owner/Town of Clayton.

G. **Water Service Shut-off.**

   The Town of Clayton requires adherence to the following procedures prior to shutting off water service on any existing Town line:

   1) The Contractor must receive approval for shut-off from the Engineering Director. Generally, shut offs must occur from 9:00 AM to 11:00 AM and 2:00 PM to 4:00 PM on weekdays.

   2) After receiving approval, Contractor shall notify affected residents in writing 48 hours in advance of beginning operation.

H. Before Digging, contact ***"NC One Call"*** at 811 and the Town of Clayton at 919-553-1530 for location services.

1.11 PUBLIC CONVENIENCE

The contractor shall at all times so conduct his work as to ensure the least possible inconvenience to the general public and the residents in the vicinity of the work. Fire hydrants on or adjacent to the work shall be kept accessible to firefighting equipment at all times. Temporary provisions shall be made by the Contractor to ensure the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches, which shall not be obstructed except as approved by the Engineering Director.

1.12 TRAFFIC CONTROL

A. When working within any NCDOT system road or highway, conform to the *Manual on Uniform Traffic Control Devices*, latest revision (MUTCD) as well as the NCDOT Standard Specifications for Roads and Structures, latest revision.

B. Traffic Maintenance shall comply with the latest revision of the NCDOT Standard Specifications for Roads and Structures, Division 9 – *Signing* and Division 11 – *Work Zone Traffic Control*, as well as other applicable sections.

C. A traffic control plan shall be submitted to the Town of Clayton Police Department and NCDOT (if applicable) for approval.

D. When traffic signals or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the NCDOT or the Engineering Director. Provide 1 weeks' notice prior to anticipated disturbance or interruption.

E. Whenever it becomes necessary to leave a section of trench open after completion of the day's work, the contractor shall provide barricades and lights to protect the public. Operate warning lights during hours from dusk to dawn each day and as otherwise required for inclement weather and visibility.

1.13 EROSION AND SEDIMENTATION CONTROL AND NPDES MONITORING, CONTROLS, AND LIMITATIONS FOR PERMITTED DISCHARGES

The Project Engineer shall submit a sedimentation and erosion control plan and permit application to the Town of Clayton and obtain all necessary construction permits. The Contractor shall follow all local and state requirements regarding sedimentation and erosion control. Construction methods shall minimize sedimentation and erosion.

The compliance program is a self-monitoring program. It is the Contractor's responsibility to periodically monitor the Stormwater Discharge Outfall points at the specified frequency and maintain reports as outlined in these specifications.

A. **Final Limitations and Controls for Stormwater Discharges**

During the period beginning on the effective date of the permit and lasting until expiration, the Owner (Permittee) is allowed and authorized to discharge stormwater associated with construction activity. Such discharges shall be controlled, limited, and monitored as specified below.

1) The Contractor shall implement the Erosion & Sedimentation Control plan, which has been approved by the approval authority. The approved plan is considered a requirement or condition of the general NPDES permit. Deviation from the approved plan, or approved amendment to the plan, shall constitute a violation of the terms and conditions of this general permit except that deviation from the approved plan will be allowed:

   a. To correct an emergency situation where sediments are being discharged off the site, or

   b. When minor modifications have been made for the purpose of improving the performance of the erosion and sedimentation control measures and notification of the minor modification has been made to the Town of Clayton.

   Such a deviation from the approved plan shall be noted on the approved plan maintained at the job site. During active construction, a copy of the approved plan shall be maintained on the site.

2) Equipment utilized during the construction activity on a site must be operated and maintained in such a manner as to prevent the potential or actual pollution of the surface or ground waters of the state. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not be discharged onto the ground or into surface waters. Spent fluids shall be disposed of in a manner so as not to enter the waters, surface, or ground, of the state and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in a manner so as not to allow their entry into the waters, surface or ground, of the state.

3) Herbicide, pesticide, and fertilizer usage during the construction activity shall be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act and shall be in accordance with label restrictions.

4) All wastes composed of building materials shall be disposed of in accordance with North Carolina General Statutes, Chapter 130A, Article 9 – Solid Waste Management, and rules governing the disposal of solid waste (North Carolina Administrative Code Section 15A NCAC 13B).

5) The Contractor, for the Permittee, shall control the management and disposal of litter and sanitary waste from the site such that no adverse impacts to water quality occur.

B. **Minimum Monitoring and Reporting Requirements**

Minimum monitoring and reporting requirements are as follows unless otherwise approved in writing by the Director of the Division of Water Resources.

1) All erosion and sedimentation control facilities shall be inspected by or under the direction of the permittee (the Owner and his/her Contractor). Inspections shall be made:

   a. At least once every seven calendar days (at least twice every seven days for those facilities discharging to waters of the State listed on the latest EPA approved 303(d) list[1] for construction related indicators of impairment such as turbidity or sedimentation),

   b. And within 24 hours after any storm event of greater than 0.5 inches of rain per 24-hour period.

      A rain gauge shall be maintained on the site by the Contractor and a record of the rainfall amounts and dates shall be kept by the Contractor. Submit with each payment request.

2) Once land disturbance has begun on the site, stormwater runoff discharges shall be inspected by observation for stormwater discharge characteristics as defined below at the frequency stated above to evaluate the effectiveness of the pollution control facilities or practices. If any visible sedimentation is leaving the disturbed limits of the site, corrective action shall be taken immediately to control the discharge of sediments outside the disturbed limits.

Stormwater Discharge Characteristics	Monitoring Type[1]	Monitoring Location[2]
Clarity	By observation	SDO
Floating Solids	By observation	SDO
Suspended Solids	By observation	SDO
Oil Sheen	By observation	SDO
Other obvious indicators of stormwater pollution	By observation	SDO

Footnotes:
[1] Monitoring Type: The monitoring requires a qualitative observation of each stormwater outfall. **No analytical testing or sampling is required**.
[2] Sample (observation) location: **SDO**= **S**tormwater **D**ischarge **O**utfall

3) The operator (Contractor) shall keep a record of inspections and forward copies of these reports to the Engineering Director. Visible sedimentation found outside of the disturbed limits shall be recorded and a brief explanation kept with the records as to the measures taken to control future releases. Any measures taken to clean up the sediment that has left the disturbed limits shall also be recorded. These records shall also be made

[1] *The latest approved list may be obtained from the Division of Water Quality, or from the following website location:* https://deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment/water-quality-data-assessment/integrated-report-files

available to DWQ or an authorized agent upon request. If the Engineering Director discovers sedimentation outside the limits of disturbance, the Contractor will be notified in writing and requested to remediate the situation.

4) All records of monitoring shall be turned over to the Town along with the "red lined" record water and/or sewer drawings.

C. **Schedule of Compliance**

1) The Contractor shall comply with Final Limitations and Controls specified for stormwater discharges once disturbance has begun on the site and until completion of construction or development and the establishment of a permanent ground cover.

2) During construction and until the completion of a construction or development and the establishment of a permanent ground cover, the Contractor shall provide the operation and maintenance necessary to operate the stormwater controls at optimum efficiency.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

General: Provide borrow material when sufficient satisfactory soil material is not available from excavations.

2.1.1 MATERIAL CLASSIFICATION

A. **Excavation**: All excavation material shall be classified as Undercut Excavation, Unclassified Earth Excavation, or Rock.

B. **Off-site Borrow** shall be select fill material approved by the Engineering Director from an off-site borrow source. See section 1.4.A of this specification for the definition of select fill material.

C. **Rip Rap and Rip Rap Bedding**: Rip Rap and Rip Rap Bedding shall conform to Section 1042 – *Rip Rap Materials* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Class A, B, 1, and 2 rip rap.

D. **Structures, Backfill around**: Backfill shall be approved by the Engineering Director and shall be free from large or frozen lumps, wood, or rocks more than 3 inches in their greatest dimension or other extraneous material. Porous backfill shall be #57 or #67 clean stone.

E. **Topsoil**: Topsoil meeting the definition prescribed in section 1.4.O obtained either from on-site or an off-site source.

2.1.2 SOIL CLASSIFICATION

A. **Satisfactory Soils**: ASTM D2487 soil classification group (Unified Soil Classification System) GC, SM, SC, ML, CL, CH and MH or a combination of these group symbols. However, CH and MH are permitted provided the soils have a Liquid Limit (LL) of ≤ 60 and a Plasticity Index (PI) of ≤ 30. Soils shall be free of rock or gravel larger than 3 inches in any dimension, topsoil, debris, debris-laden fill, organic matter, waste, frozen materials, muck, roots, organic materials /vegetation, and other deleterious matter.

B. **Unsatisfactory soils**: ASTM D2487 soil classification group (Unified Soil Classification System) CH (Fat Clay) and MH soils having a LL of > 60 and a PI of > 30, OH, OL, and PT; soils which contain rock or gravel larger than 3 inches in any dimension, topsoil, debris, debris-laden fill, organic matter, waste frozen materials, organic materials/vegetation, and other deleterious matter. Unsatisfactory soils also include satisfactory soils not maintained within +/- 3% of optimum moisture content at time of compaction, unless otherwise approved by the Engineering Director.

2.2 MISCELLANEOUS

2.2.1 GEOTEXTILE FABRIC:

Geotextile fabric shall be protected from mud, dirt, dust, sunlight, and debris during transport and storage. Material shall be inert to commonly encountered chemicals; resistant to mildew, rot, insects, and rodents; and biologically and thermally stable. Geotextile fabric for subsurface installation shall not be exposed to direct sunlight for more than 24 hours before or during installation. All geo-fabric to be used within the right-of-way of a Town street must be approved by the Engineering Director.

A. **Filter Fabric for Rip Rap**: Filter Fabric for Rip Rap and Rip Rap Beddings shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 2 engineering fabric.

B. **Soil Stabilization Fabric**: Generally, soil stabilization fabric shall conform to the requirements of Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 4 engineering fabric. However, provide fabric meeting Geotechnical Engineers recommendations for the application and use intended.

C. **Fabric for Subsurface Drains**: Non-woven needle-punched fabric shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 1 engineering fabric.

D. **Silt Fence Fabric**: Silt fence fabric shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 3 engineering fabric, Class A or B as specified or shown on the plans.

2.2.2 SEGMENTAL RETAINING WALLS

Segmental Retaining Wall (SRW) design and materials to conform to the plans for same prepared by an independent NC licensed Professional Engineer. Submit plans to the Engineering Director for review and approval.

No SRW reinforcement is to be placed within the Town of Clayton's street right of way unless otherwise approved by the Engineering Director.

2.2.3 PERMITS

See Sections 1.8 Project Conditions, 1.10 Coordination, 1.12 Traffic Control and 1.13 Erosion & Sedimentation Control, above for permitting requirements.

PART 3 – EXECUTION

3.1 GENERAL

3.1.1 GENERAL REQUIREMENTS APPLYING TO ALL AREAS

A. Contractor shall plan construction to minimize disturbance to properties adjacent to the project site and be within the construction limits shown on the plans.

B. The Engineering Director reserves the right to limit the width of land to be disturbed and to designate on the drawings or in the field certain areas or items within this width to be protected from damage.

C. **Access and/or Haul Roads**: Any grading or excavation required for equipment travel during the course of construction as well as erosion control, access or haul road removal, restoration, seeding and ground cover shall be provided by the Contractor.

D. The Contractor shall be responsible for damage to areas or items designated by the Engineering Director to be protected. Repairs to, replacement of, or reparations for areas or items damaged shall be made at the Contractor's expense and to the satisfaction of the Engineering Director before acceptance of the completed project.

E. The Contractor shall protect all existing buildings or structures.

F. Any fences disturbed by the Contractor shall be repaired with new materials to a condition equal to or better than their original condition or to the satisfaction of the Engineering Director at no additional cost.

G. The Contractor shall obtain written permission from property owners for use of any access other than ones located within rights-of-way or easements. Written permission shall contain conditions for use and restoration agreements between the property owner and the Contractor.

H. All areas disturbed shall be restored to a condition equal to or better than their original condition and shall be graded to drain.

I. The Contractor shall replace or repair all damaged or destroyed hedgerows and property corners using the services of a licensed Professional Surveyor.

J. **Existing Conditions Record**: To protect both the Town and the project owner, if applicable, from unwarranted third-party claims, the Contractor shall video or

photograph (ground based or drone) the site and adjoining properties to obtain a "pre-existing conditions" photographic survey of project. Retain data and, if requested by the Town, provide a copy on a thumb drive or similar portable device.

3.1.2 CONSTRUCTION LIMITS

A. The Contractor shall not disturb any areas outside the limits contained in this section without express written permission from the Engineering Director.

B. Except as indicated on the plans, no "clear cutting" of timber shall be permitted within the construction limits. The Contractor shall make select cutting of trees, taking smallest trees first, that are mandatory for the construction. The decision of the Engineering Director shall be final on the determination of which trees are to be cut.

C. Should it become necessary to move the position of any underground structure, the Contractor may be required to do such work and shall be paid on a force account basis or on an extra work basis as directed by the Engineering Director. Method of payment shall be agreed upon by the Engineering Director and the Contractor prior to commencing work.

D. If existing utilities are found to interfere with the permanent facilities being constructed under this section, immediately notify the Engineering Director and secure instructions. Do not proceed with permanent relocation of utilities until instructions are received from the Engineering Director.

E. **Specific requirements applying to developed subdivision/lots**

1) Unless directed otherwise by the Engineering Director, all trees, shrubs, hedges, or other ornamental plantings located outside of the construction limits, easements, or public rights-of-way shall be protected by the Contractor. The Engineering Director reserves the right to designate certain trees located within the construction limits for protection were deemed desirable.

2) The Contractor shall protect septic systems or springs located outside the construction limits.

3) Excavated or blasted rock shall be removed from the site unless otherwise ordered by the Engineering Director.

F. **Specific requirements applying to undeveloped areas**

1) In wooded areas, the clearing shall be limited to the easement or right-of-way limits unless indicated otherwise on the Town of Clayton approved construction drawings, in which case, the work shall be confined to the limits defined on the plans. All permanent easements and rights-of-way shall be fully cleared. The Engineering Director reserves the right to designate certain trees located within the construction limits for protection where deemed desirable.

3.1.3 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. **Subsurface obstructions**

1) **Subsurface obstructions**: Take necessary precautions to protect existing utilities from damage due to any construction activity. The Contractor shall locate existing utilities, culverts, and structures (above or below ground), before any excavation starts and coordinate work with utility companies. The Contractor shall be responsible for notifying utility companies when working within the vicinity of the existing utilities. Omission from or inclusion of located utility items on plans do not constitute non-existent or definite location. Even though for convenience, the utility may be shown on the plans, the Contractor is responsible for and shall call for utility location a minimum of 48 hours prior to excavations. Contact underground damage protection locator services, **NC811**, at 811 or 800-632-4949 and the Town of Clayton at 919-553-1530. Secure and examine local utility surveyor records for available location data including building service lines.

2) Unless shown to be removed, protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to excavation. In excavating, care must be taken not to remove or injure any subsurface structure. All existing gas pipes, water pipes, steam pipes, telephone lines, cable TV lines, electrical conduits, sewers, drains, fire hydrants, and other structures which, in the opinion of the utility company, do not require relocation shall be carefully supported, shored up, the flow maintained, if applicable, and the line/main protected from damage by the Contractor. If damaged, the Contractor shall give immediate notice to the proper authorities. The utility shall be restored, at the Contractor's expense, by the appropriate utility to original or better condition. Where pipes, conduits, or sewers are removed leaving dead ends in the ground, such ends shall be carefully plugged or bulkheaded by the Contractor at the Contractor's expense. The Contractor shall be responsible for any damage to persons or property caused by such breaks.

3) The Contractor shall be responsible for anticipating and locating underground utilities and obstructions. When construction appears to be in close proximity to existing utilities, test pits shall be made a sufficient distance ahead of the work to verify the exact locations and inverts of the utility to allow for changes in grade or utility relocation.

4) If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.

5) Should it become necessary to move the position of any underground structure, when approved by the Engineering Director, the Contractor may be required to do such work and shall be paid on a force account basis or on an extra work basis.

6) If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineering Director and secure his instructions. Do not proceed with permanent relocation of utilities until written instructions are received from the Engineering Director.

B. **Protection of Surface Features**

1) Whenever construction is to take place on or near a paved street, the Contractor shall provide pads or take necessary precautions to protect the pavement from damage by the construction equipment. Pavement damaged by cleated or tracked equipment, or by any other means, shall be repaired by the Contractor at his expense to the satisfaction of the Engineering Director.

2) Where joining existing pavements, the Contractor shall use care to cut the existing pavement in sharp, neat lines. If the existing road to be cut is located within another jurisdiction other than the Town of Clayton or within NCDOT rights of way, the Contractor is responsible for contacting the person or persons responsible for said road about pavement repair/replacement.

3) Avoid overloading or surcharging. Provide a sufficient distance back from edge of excavation or fill to prevent sloughing, slides, or caving. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property.

4) Provide full access to public and private premises, to fire hydrants, at street crossings, sidewalks and other points as designated by the Engineering Director to prevent serious interruption of travel.

5) Protect and maintain benchmarks, monuments, or other established points and reference points and if disturbed or destroyed, items shall be replaced by a Licensed Land Surveyor to full satisfaction of the Engineering Director and the jurisdictional agency.

6) See 1.10 Coordination, paragraph D regarding traffic signal conflicts.

7) Identify and protect landmarks, street signs monuments, and other such features.

C. **Procedures for repairing damaged utility services**

1) If a located service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Town.

2) **House services**: If a service pipe supplying water or sewer service to an adjoining house is broken, the Contractor shall repair it at once and at his expense. The Town may, at the Contractor's expense, repair any such service without prior notice to the Contractor.

3.1.4 PROTECTION OF PERSONS AND PROPERTY

A. Barricade open holes and depressions occurring as part of the work, and post warning lights on property adjacent to or part of public access.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this or other related sections.

C. **Protection and Restoration of Property:** The Contactor shall not enter upon private property for any purpose without first obtaining written permission from owner. The Contractor shall use every precaution necessary to prevent damage or injury to any public or private property, trees, fences, monuments, and underground structures, etc., on and adjacent to the site of the work. The Contractor shall protect from disturbance or damage all land monuments and property markers until an authorized agent has witnessed or otherwise referenced their locations and shall not remove them until directed.

The Contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect, or misconduct in his manner or method or executing said work, from his nonexecution of work, or from defective work or materials, and he shall not be released from said responsibility until the work shall have been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, he shall restore such property, at his own expense, to a condition equal to or better than that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring, and may be directed or he may make good such damage or injury in an acceptable manner.

The Contractor shall, at his own expense, sustain in their places and protect from direct or indirect injury all pipes, poles, conduits, walls, roadways, buildings, and other structures, utilities and property in the vicinity of his work. Such sustaining and supporting shall be carefully done by the Contractor and as required by the Company or party owning the structures or Agency controlling it. The Contractor shall take all risks attending the presence or proximity of pipes, poles, conduits, walls, thereof and any costs associated will be deducted from any monies due the Contractor. **Failure of the Engineering Director or his/her authorized representative to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder**.

3.2 CLEARING AND GRUBBING

A. **Description**: This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, as designated on the plans or as required by the Engineering Director. The work shall also include the preservation from injury or defacement of all vegetation or objects designated to remain. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, downed timber, brush, rocks, projected roots, stumps, rubbish, laps, and other material within easement.

B. A preconstruction meeting shall be held with appropriate forestry personnel (if applicable) and the Town prior to any clearing, if required. The Engineering Director may require tree protection fencing in sensitive areas, where specifically identified trees are desired to be protected, and when required by the landscape ordinance.

C. The area within the limits of construction or as designated shall be cleared and grubbed of all trees, stumps, roots, brush, undergrowth, hedges, heavy growth of grasses or weeds, debris and rubbish of any nature that, in the opinion of the

Engineering Director, is unsuitable for foundation material. Nonperishable items that are not deleterious to the project and will be a minimum of 5 feet below the finish elevation of the earthwork or slope of the embankment may be left in place.

D. The Contractor shall provide barricades, fences, coverings, or other types of protection necessary to prevent damage to existing improvements, not indicated to be removed, and improvements on adjoining property. All improvements damaged by this work shall be restored to their original condition to a condition acceptable to the owner or other parties or authorities having jurisdiction. Trees and shrubs that are to remain within the construction limits will be indicated on the drawings or conspicuously marked on site. Unless otherwise noted, trees within the construction limits shall become the property of the Contractor and shall be removed from the site.

E. Contractor shall protect existing trees and other vegetation indicated by the Engineering Director to remain in place against limb, bark or root damage such as cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. When such damage does occur, all rough edges of scarred areas shall be removed in accordance with accepted horticultural practices.

F. Carefully and cleanly, cut roots and branches of trees indicated to remain where the roots and branches obstruct construction of a proposed utility line. If directed by the Engineering Director, the Contractor shall provide protection for roots and branches over 1 ½ inches diameter that is cut during construction operations. Coat the cut faces with emulsified asphalt, or other coating especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out. Provide earth cover as soon as possible.

G. Trees and vegetation designated to remain shall be repaired or replaced at Contractor's expense in a manner acceptable to the Engineering Director if they are damaged by construction operations. Repair tree damage as directed by a qualified tree surgeon.

H. Debris from the site shall be removed in such a manner as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, dust, and debris at all times.

I. The method of stripping, clearing, and grubbing the site shall be at the discretion of the Contractor. However, all stumps, roots and other debris protruding through the ground surface or in excavated areas shall be completely removed and disposed of off the site by the Contractor.

J. **Marginal Areas**: In marginal areas, with the Engineering Director's permission, remove trees where the following conditions exist.

1) **Root Cutting**: When clearing up to the "clearing limits," the Contractor shall also remove any tree which is deemed marginal such that when the roots are cut and the tree could be rendered unstable by the effects of high winds and in danger of toppling into either the right-of-way or onto private property.

2) **Slender Bending Trees**: Where young, tall, thin trees are left unsupported by the clearing operation, and are likely to bend over into the right-of-way, the Contractor, during the clearing operation, shall selectively remove those trees which are located outside and adjacent to the clearing limits and Town right-of-way or easement as well. During the course of construction and during the one-year warranty period, the Contractor shall remove such young trees that overhang into the right-of-way or cleared area.

K. **Stripping of Topsoil**: Unless otherwise shown on the approved drawings, remove the existing topsoil to a depth of 6 inches or to the depth encountered from all areas in which excavation will occur. The topsoil shall either be stored in stockpiles separate from the excavated trench material if the topsoil is to be respread or otherwise disposed of off-site. Topsoil stockpiles shall be graded to freely drain surface water and shall have a silt fence placed around the base of the stockpile.

L. **Disposal**: All brush, treetops, stumps, and debris shall be hauled away and disposed of in accordance with all applicable laws and regulations. The Contactor shall clean up debris resulting from clearing operations continuously with the progress of the work and remove promptly all salvageable material that becomes his property and is not to be reused in construction. Sale of material on the site is prohibited.

The disposal of cleared material shall be in accordance with all local and state laws. Trees cut down on the construction site will be hauled away from the site for proper disposal unless instructed otherwise by the Town. Stumps of trees cut down outside of the excavation area will be removed. Perishable material shall not be disposed of at the construction site. Brush, limbs, roots, and stumps from trees shall be disposed of in a NCDEQ Waste Management, Solid Waste Section approved and permitted land clearing and inert debris (LCID) type landfill. The Contractor will be responsible for obtaining all applicable permits and paying all fees for the disposal of excess material.

3.3 UNCLASSIFIED EXCAVATION, UNDERCUTTING, BORROW, EMBANKMENT:

3.3.1 DESCRIPTION

Prior to beginning grading or embankment operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with these specifications.

Should the Contractor, through negligence or other fault, excavate below the designated grades, he shall replace the excavation with approved satisfactory materials, in an approved method, at his own expense. All material determined unsatisfactory shall be disposed of in waste areas as directed. Topsoil shall not be used in embankments but shall be handled and placed as directed.

The Contractor shall satisfy himself as to the character, quantity, and distribution of all materials to be excavated. No payment will be made for any excavated material that is used for purposes other than those designated.

3.3.2 CONSTRUCTION METHODS

A. **Excavation**: Excavation shall be performed as indicated on the plans or as directed by the Engineering Director to the lines, grades, and elevations, and shall

be finished to a reasonable smooth and uniform surface. During the process of excavation, the grade shall be maintained, and surface shall be shaped and rolled so that it will be well drained at all times.

When solid rock is incurred in the excavation, the rock shall be removed to a minimum depth of 12 inches below the surface of the proposed subgrade elevation. Material unsatisfactory for subgrade foundation shall be removed to a depth specified to provide a satisfactory foundation. The portion so excavated shall be refilled with suitable material obtained from the grading operations or borrow area and thoroughly compacted by rolling. The Engineering Director must approve material obtained from onsite grading operation. For areas that do not require fill, scarify, and compact to a depth of 6 inches.

Any removal, manipulation, aeration, replacement, and recompaction of suitable materials necessary to obtain the required density shall be considered as incidental to the construction operations and shall be performed by the Contractor at no additional cost to the Town.

No rock, stone, or rock fragments, larger than 3 inches in their greatest dimension will be permitted in the top 12 inches of the subgrade. No rock, stone, or rock fragments larger than 8 inches in their greatest dimension will be permitted in the remainder of the fill.

B. **Stabilization of soft subgrade with Geotextile**: The use of Geotextile material for subgrade stabilization shall be approved by the Engineering Director (or a Geotechnical Engineer if required) and shall meet the requirements of paragraphs 2.2.1.B *Soil Stabilization Fabric* and 3.9 *Placement of Soil Stabilization Fabric*.

C. **Moisture Conditioning**: When on-site "satisfactory" soils are known to be moisture sensitive (i.e., USC system MH, CH), they can be difficult to work. Problems associated with moisture sensitive soils include softening of exposed subgrade soils, excessive rutting or deflection under construction traffic, and the inability to adequately dry and compact wet soil.

Drying and compaction of wet soils is difficult during the cooler wetter months of the year (typically November through March). During the cooler and wetter periods of the year, the Contractor should anticipate delays and additional costs. When encountered during these times of the year, the Engineering Director may require that a reduction of soil moisture be accomplished by a combination of mechanical manipulation and the use of chemical additives, such as lime or cement, in order to lower moisture contents to levels appropriate for compaction or that the Contactor secure the services of a Geotechnical Engineer for guidance in addressing wet soil conditions. Alternatively, removal and replacement with drier, off-site materials may be necessary.

D. **Subgrade Protection**: Measures should also be taken to limit site disturbance, especially from rubber-tired heavy construction equipment, and to control and remove surface water from development areas, including building and pavement areas. It would be advisable to designate and cover haul roads and construction staging areas to limit the areas of disturbance and to prevent construction traffic from excessively degrading subgrade soils. Haul roads and construction staging areas should be covered with ABC to protect those subgrades.

E. **Borrow**: Borrow shall not be used until all suitable, on-site, excavated material has been placed in the embankment, unless authorized by the Engineering Director. Unless otherwise designated on the plans and contract documents, the Contractor shall make his own arrangements for obtaining select fill material for borrow and pay all costs involved. If the Contractor places more borrow than is required, and thereby causes a waste of excavation, the amount of such waste, unless authorized, will not be included for payment.

F. **Embankments**:

1) **Evaluation of In-situ or Embankment Fill Subgrade**: Prior to placement of compacted fill, the Engineering Director or his representative shall carefully inspect the exposed subgrade. The Contractor shall then proof roll the exposed subgrade, in the presence of the Engineering Director or his representative. The inspection shall include, but not be limited to, proof rolling the prepared subgrade with a rubber-tired fully loaded quad axle dump truck (16 CY dump bed) that has a minimum gross payload weight of at least 50,000 pounds (25 tons)[2]. Leave the lift axles in up position to affectively yield a tandem axle proof roll. No other method will be acceptable. Any unsatisfactory materials thus exposed shall be removed and replaced with satisfactory select material as approved by the Engineering Director. Provide the necessary amount of select fill compacted to the density requirements outlined in this specification.

The Town reserves the right to reject any subgrade (in-situ soil or embankment fill) that has not been approved, a subgrade that has been rained on, or a subgrade that is frozen after the previous inspection prior to being covered with fill or stone base.

Any subgrade that has been rained on or frozen after proof roll, but prior to being covered with base, will be required to have another proof roll prior to placement of base.

Partial approvals of subgrade improvements will not be provided unless a visual means of station identification is clearly marked in the field along the street (or gridding for sites).

2) **Preparation of Ground Surface for Embankment Fill**. Before fill is placed, scarify existing grade to a minimum depth of 6 inches. In areas where the existing or proposed ground surface is steeper than one vertical to four horizontal (4:1), plow surface in a manner to bench and break up surface so that fill material will bind with the existing surface.

3) Embankments shall be made of satisfactory soil material and shall be built in successive horizontal layers of not more than 8 inches in loose depth for the full width of the cross sections.

The material entering the embankment in each of the layers shall be within a tolerance of plus or minus +/- 20% of the optimum moisture content before rolling to obtain the prescribed density. Wetting or drying of the material and manipulation when necessary to secure uniform moisture

[2] Empty Truck weight = 20,000 lbs. to 28,000 lbs.

content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on the embankment shall be delayed until the material has dried to the required moisture content. If high moisture is due to negligence of Contractor due to improper drainage, the Engineering Director may require removal and replacement of material. See paragraph 3.3.2.C Moisture Conditioning, above.

4) Fill material shall not be placed on frozen ground or areas covered with ice and/or snow or areas with a moisture content above optimum.

G. **Undercut Excavation**: Undercut Excavation: Undercut excavation shall consist of the removal and satisfactory disposal of all unsuitable material located below subgrade elevation. Where excavation to the finished grade section results in a subgrade or slopes of muck, peat, matted roots, etc., the Contractor shall remove such material below the grade shown on the plans or as directed; and areas so excavated shall be backfilled with approved select borrow as ordered by the Engineering Director. For definition of undercut excavation, see *paragraph 1.4G – Unclassified Excavation (Undercut)*.

H. **Preparation of areas to receive asphalt pavement or concrete**:

1) **Areas to be Paved**: After all excavation, undercutting, and backfilling has been completed, the subgrade shall be properly shaped and thoroughly compacted. The compactive effort shall include all areas beneath pavement and shall extend at least a minimum of 1 foot beyond the paving limits. Compaction shall be in accordance with Table 02200-2.

2) **Evaluation of Areas to be Paved**: The Contractor shall then proof roll the exposed prepared stone base course subgrade in the presence of the Engineering Director or his representative. The inspection shall include, but may not be limited to, proof rolling the prepared base course subgrade with a rubber-tired fully loaded quad axle dump truck (16 CY dump bed) that has a minimum gross payload weight of at least 50,000 pounds (25 tons)[3]. Leave the lift axles in an up position to effectively yield a tandem axle proof roll. Proofrolling shall be performed in lengths of not less than one block as measured from center of intersection to center of intersection, from center of intersection to end of cul-de-sac, or 750 linear feet. **No other method will be acceptable**. Any unsatisfactory materials (stone base course and/or soil subgrade) thus exposed shall be removed and replaced with satisfactory select material and stone base as approved by the Engineering Director. Provide the necessary amount of select fill compacted to the density requirements outlined in this specification. (See section 3.3.2 paragraph H.3, below regarding C&G base proof rolling).

Areas of the stone base course that rut or pump excessively under the wheels of the proof roller shall be repaired by the Contractor before any work continues.

Any stone base course that has been rained on or frozen after proof roll, but prior to being covered with pavement, will be required to have another proof roll prior to placement of pavement.

[3] Empty Truck weight: Can vary from 20,000 lbs. to 28,000 lbs.

Partial approvals of stone base course improvements will not be provided unless a visual means of station identification is clearly marked in the field along the street (or gridding for sites).

The Town reserves the right to reject any stone base course subgrade that has not been approved, a stone base course subgrade that has been rained on, or a stone base course subgrade that is frozen after the previous inspection.

3) **Curb and gutter, sidewalks and driveway aprons**: The subgrade shall be constructed true to grade and cross section as may be shown on the drawings or standard details. Compaction shall be in accordance with Table 02200-2.

The subgrade shall be graded and protected as to prevent an accumulation of standing water, and consequent subgrade saturation, in the event of rain. Do not place any concrete sidewalk or driveway apron on a subgrade that has been rained on, a subgrade that is frozen or a hot and dry subgrade without first moistening the subgrade. A dry subgrade will steal water from the concrete mix and affect set time and concrete quality.

Curb and Gutter:
Prior to construction of curb and gutter, the Town reserves the right to reject any curb and gutter subgrade that has not been approved, a subgrade that has been rained on, or a subgrade that is frozen after the previous inspection.

When a stone base course is placed under the curb and gutter that is 4 inches or less in thickness, the stone base course will not require density tests but will require a proof roll (with a rubber-tired fully loaded quad axle dump truck [16 CY dump bed] that has a minimum gross payload weight of at least 50,000 pounds).

I. **Grading tolerances of finished surface**: Earthwork shall conform to the lines, grades, and typical cross sections shown on the plans, standard details, or as established by the Engineering Director. Changes in grade shall be accomplished by smooth curves.

1) Shape subgrade under pavement and curb and gutter to within ½ inch of required subgrade elevations.

2) Finish pavement and curb and gutter to within ¼ inch of required finish elevations.

3) Shape subgrade under sidewalks to within 0.10 foot of required subgrade elevations.

4) Finish sidewalks to within 0.10 foot of required finish elevations.

5) For all other areas, subgrade and finish elevations shall be within 0.10 foot of required corresponding elevations.

J. **Backfill of Curb and Gutter and sidewalks**: Immediately after the removal of forms for curb and gutter, sidewalks and driveways, the space between the back of the curb, sidewalks, and driveways shall be backfilled and smoothed off in a manner to prevent the accumulation of standing water.

K. **Subgrade Testing & Compaction Requirements**: Refer to paragraphs 3.5 *Subgrade Compaction Testing and Control* and 3.6 *Subgrade Preparation and Compaction Requirements*.

3.4 ROCK:

3.4.1 GENERAL

A. Blasting procedures shall conform to all applicable local, state, and federal laws and ordinances and shall be performed in accordance with OSHA *Standard 29 CFR part 1910.109*, NCDOT Rules for Transporting Explosives, and local Fire Department Regulations. Prior to any blasting, a blasting permit shall be obtained. The approval of the Engineering Director shall be obtained before any blasting takes place and the Engineering Director may fix the hours of blasting if he/she deems it necessary. The use of explosives shall be in accordance with approved methods that safeguard lives and property. Explosives shall only be handled, placed, and detonated by persons licensed in this work. It is the responsibility of the Contractor to provide proper notification to appropriate parties.

B. **Rock Excavation – Definition**: See paragraph 1.3 I for definition of rock excavation in open excavation.

C. The minimum insurance coverage for blasting shall be as specified by the Engineering Director. The coverage shall include explosion and collapse. If blasting occurs within 200 feet of any underground structure or utility, underground coverage will be required. The Town and the property owners shall be named as "additional insured."

D. **Storage**: Store explosives in accordance with the Occupational Safety and Health Act, the N.C. Department of Labor Occupational Safety and Health Division's *A Guide to the Safe Storage of Explosive Materials*, and with other Federal, State and Local ordinances and regulations. A locked type 2 or 3 (as applicable) portable magazine shall be placed on site for storage of high and/or low explosives, detonators, detonating cords, ignitors and blasting agents; all in accordance with Federal and State OSHA requirements and guidelines and local permitting requirements. The These boxes shall be plainly identified as to their contents. Failure to comply with this specification shall be grounds for suspension of blasting operations until full compliance is made. No blasting shall be allowed unless a galvanometer is employed to check cap circuits.

E. The Town may prohibit blasting when the method of detonation or the means of protection provided is inadequate. Blasting conducted with or without direct supervision of the Town will not relieve the Contractor of the responsibilities stipulated herein.

F. Blasters shall not explode or attempt to explode blasting powder or high explosives unless it is performed with a suitable electric blasting machine. Electric current from batteries, telephone, or power lines shall not be used for detonation.

G. A minimum of 3 minutes prior to the detonation, the blaster shall inform competent flagmen, equipped with red flags, stationed at reasonable distances from the blast area at every avenue of approach, to warn all persons.

H. Immediately after the loading and tamping of the drill hole and before fixing the blast, the material to be blasted shall be covered on all exposed sides with blasting mats, or other approved protective material. After the protection has been applied, the blast shall be fired without unnecessary delay.

3.4.2 BLASTING PROCEDURE

A. The Contractor shall provide a blast warning signal system. The blast warning signal system shall consist of one or more air horns located at the blast site. The air horn(s) shall be audible a minimum of 1 mile from the blast site. The signals shall be one long horn five minutes prior to the blast, one short horn 1 minute prior to the blast, and one long horn after the blast to signal all clear. The Contractor shall erect two clear and legible blast warning signal signs at locations determined by the Engineering Director. The signs shall list the blast warning signal system, the Contractor Superintendent's name and telephone number, and the Town representative's name and telephone number.

B. The Contractor shall establish test pits at up to two representative locations along the alignment and up to three locations adjacent to the site proposed to be blasted to determine if the rock is "rippable" with a D-8 or equivalent dozer drawing a new single-tooth ripper (see paragraph 1.3 I for definition of rock excavation in open trenches). If these procedures do not offer reasonable production for rock excavation, then blasting will be allowed unless otherwise indicated.

C. The Contractor shall notify in writing all property Owners within 250 feet of the proposed blast at least 1 week prior to the proposed blast and verbally on the day of the scheduled blast.

D. Blasting shall be limited to mid-morning hours on days of clear-to-partly cloudy skies with increasing surface temperature and light wind. The Contractor shall provide monitoring equipment to monitor all blasting. A copy of the monitoring record shall be given to the Town daily.

E. The use of unconfined explosives shall be prohibited.

F. Unless otherwise stipulated in Title 13 of the NC Administrative Code, chapter 7, the maximum allowable peak particle velocity shall be 1.25 inches per second for all structures located 0 to 300 feet from the blasting site. The maximum allowable peak particle velocity shall be 1.00 inch per second for all structures located 301 to 5,000 feet from the blasting site. The maximum allowable peak particle velocity shall be 0.75 inch per second for all structures located 5,001 feet and beyond from the blasting site.

G. To minimize vibration, minimum-scaled distance (SD) of 50 shall be used to determine maximum explosive weight per delay. A test blast shall be conducted to verify the scaled distance. The maximum explosive weight per delay shall not exceed the distance from the blast to the nearest structure divided by 50 squared. Maximum explosive weight per delay may be revised pending outcome of test blast. The recommendations indicated for blasting criteria in no way relieves the Contractor of his liability.

H. The peak overpressure of air blast shall not exceed 0.015 pound per square inch or 138 decibels.

I. Preblast meetings may be scheduled with the Engineering Director to document hole depths and spacing, charge weight per delay, shot scheduling, and weather conditions. The Contractor shall obtain accurate measured distances from structures to center of blast area prior to determining the safe maximum charge-weight per delay and loading blast holes.

J. Preblast and post blast surveys will be performed by the Contractor. The Contractor may review this data and supplement it as he sees fit or conduct separate survey after written permission is obtained from the property Owners. In this event, the written permission shall be submitted to the Engineering Director prior to entering upon private property. The preblast and post blast surveys will include all occupied buildings within 250 feet of blasting areas. The Contractor is strongly encouraged to have a representative present during these surveys. The preblast and post blast surveys performed by the Town or the property owner in no way relieve the Contractor of his liability.

K. The Town reserves the right to monitor production blasting. In this event, the Contractor shall provide the Engineering Director ample notice of scheduled blasts to allow set-up of monitoring equipment.

3.4.3 DISPOSAL OF ROCK

Excavated rock shall be hauled off the site at the Contractor's expense. Borrow required to replace excavated rock shall be provided by the Contractor and shall be included in the unit price bid for rock excavation in open trenches. No rocks or boulders shall be used as backfill in any part of the site unless otherwise approved by the Engineering Director. Where rock has scattered over adjoining property as a result of blasting, the Contractor shall remove the rock and restore the area to its original condition at no cost to the Town.

3.5 SUBGRADE COMPACTION TESTING AND CONTROL

A. **Testing**

Testing of embankment/borrow shall be performed by an independent laboratory approved by the Town and the Contractor. The Contractor shall be responsible for excavation for testing if required.

Quality Assurance vs. Quality Control:

Quality Assurance (QA) testing, and the associated cost, is the responsibility of the Town. Quality Assurance testing by the Town is used to confirm that the Contractor is generally performing his/her work in compliance with these specifications.

Quality Control (QC) testing is the necessary and required testing that is to be performed by the Contractor to assure that he/she is meeting and complying with the requirements of these specifications. The associated cost for QC testing is the Contractor's responsibility. The Contractor is also responsible for "re-testing" costs incurred by the Town when the Town tests results (tests for Quality Assurance) results in a "failure."

Quality Control (QC) testing for Town funded projects: The Town shall pay for the cost of Quality Control by having the Contractor include the cost for testing in the unit cost of the project; not as a separate pay item. The Contractor shall pay for all costs associated with re-testing.

B. **Quality Assurance (QA):**

In the course of placement of embankment fill/borrow or in utility trench backfill, the Engineering Director may require additional "Field Density Determinations" or compaction tests. Such tests will be at the Town's expense. When compaction tests are called for by the Town, the Engineering Director will determine the location of the tests and the Town shall engage a qualified testing firm to perform the test. A representative of the Town will observe tests and a copy of the test results and inspection report will be submitted by the testing firm directly to the Engineering Director. When the tests indicate that the density failed to meet the requirements of Tables 02200.2A and 2200.2B, the Contractor shall comply with paragraph 3.6 D, Failure of Compactive Efforts.

Payment for failed QA density tests: For Town funded projects, payment for failed in-place density tests shall be made by the Contractor by deducting the testing cost from the forthcoming retainage. For other projects in which the Town will ultimately assume ownership and maintenance, the testing costs for failed in-place density tests shall be billed directly to the Contractor.

C. **Quality Control (QC):** The Contractor shall perform in-field density tests in accordance with Table 02200-1. Inspection reports shall be submitted by the testing firm directly to the Engineering Director designee. See paragraph 3.6 C, Passing Test.

1) All test results shall be provided to the Engineering Director designee as they become available from the testing agency.

2) The Geotechnical testing firm is to perform laboratory tests (ASTM D698, Standard Proctor) to establish a moisture-density relationship for all materials that are proposed to be used as fill.

3) Contractor shall give a 24-hour notice to Geotechnical testing firm for subgrade testing, subgrade confirmation, or inspections.

4) **Minimum Compaction Testing Frequency**:

The following testing frequency shall be employed on both City funded projects and projects proposed to be turned over to the City for maintenance and/or ownership.

Table 02200-1	
Testing Frequency	
Location	**Frequency**
Buildings and structures	1 test group[a] for every 5,000 square feet
Road	1 test group for every 300 feet of road
Parking Lots	1 test group for every 10,000 square feet
Unpaved areas	1 test group for every 20,000 square feet

Table 02200-1	
Testing Frequency	
Location	**Frequency**
Pipe Trenches in Roadways	1 test group for every 100 feet 1 test in each lateral (not to be taken at surface of trench)
Proof Roll	Entire surface area to be paved
Exception: Where additional tests are required to determine the extent of unacceptable compaction (having been determined by the initial QA/QC test.	

[a] One test group consists of compaction tests on each layer of fill and backfill material.

D. **Site access for testing:** Ensure Town, at all times, has immediate access to the site for the testing of all soil-related work. Ensure excavations are in a safe condition for testing personnel.

3.6 SUBGRADE PREPARATION AND COMPACTION REQUIREMENTS

A. **Confirmation of Initial Geotechnical Report/Design Assumptions** *(for roadway projects to be turned over to the Town)*: Prior to placement of stone base over the subgrade, the Geotechnical Engineer or his representative shall confirm the initial test results and design assumptions by visual classification and hand augur borings. If the visual findings are at variance with the initial testing and design assumptions, recommendations for modifications to the subgrade shall be provided to the designer, the Grading Contractor, and the Engineering Director. The Engineering Director shall approve the proposed recommendations prior to incorporation of the measures.

B. **Minimum Compaction Requirements**: Compaction percentages are percentages of maximum dry density as determined by indicated ASTM Standards. Unless noted otherwise on drawings or more stringently by other sections of these specifications, place and ensure degree of compaction of embankment and borrow materials does not fall below the following percentages of the maximum density at optimum moisture content.

C. **Passing Test:** Average of 3 test results meeting the applicable provisions of tables 2200.2A and 2200.2B (below) with no one test failing by more than -3 percentage points. Moisture content tolerance is to be within +/- 3 percentage points of the optimum moisture content unless otherwise specified by the Engineering Director or Geotechnical Engineer.

Table 2200.2A		
Minimum Compaction Limits		
Location	**Density**	
Site and Public Roadways		
Embankment/borrow under roadway pavement surfaces,	Top 12 inches	100% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99.

Table 2200.2A		
Minimum Compaction Limits		
Location	**Density**	
Site and Public Roadways		
sidewalks, and curb and gutter	Up to within 12 inches	95% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99.
Roadway Shoulders	95% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99.	
Under turf, sodded, planted, or seeded non-traffic areas	90% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99.	
Stone Base	100% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99.	
Greenways: embankment/borrow	90% of the maximum dry density by ASTM D698 (Standard Proctor), AASHTO T99[A]	
Greenway Stone Base	92% of that obtained by compacting a sample of material in accordance with AASHTO T180 as modified by NCDOT for both nuclear and ring test[A]	

[A]NCDOT *Bicycle & Pedestrian Greenway Design Guidelines*, October 14, 2013

Table 2200.2B		
Location	**Density**	
Building Structures		
Embankment/borrow beneath and within 5 feet of buildings, under foundations, and scarified existing subgrade beneath buildings.	Top 12 inches	100% of the maximum dry density by ASTM D698 (Standard Proctor)
	Up to within 12 inches	95% of the maximum dry density by ASTM D698 (Standard Proctor)
Outside structures next to walls and any other structural exterior member	90% of the maximum dry density by ASTM D698 (Standard Proctor)	
Backfill less than 10 feet from exterior retaining walls	90% of the maximum dry density by ASTM D698 (Standard Proctor)	

D. **Failure of compactive efforts**: If compaction efforts should fail to provide a stable subgrade in accordance with the requirements in paragraph 3.6 C, Passing Test after subgrade materials have been shaped and brought to optimum moisture, such unstable materials shall be removed to the extent directed by the Geotechnical Engineer and/or the Engineering Director and replaced and compacted using new material and must pass compaction test prior to proceeding to the next stage of construction and at no expense to the Town.

The costs associated with excavation and re-compaction of areas that have failed will be the Contractors' responsibility.

E. **Compaction Lifts**:

Table 2200.3	
Compaction Lift Thicknesses	
Compacted Lift Thickness (inches)	**Location**
6[A, B]	Inside street rights-of-way
12	Outside street rights-of-way

[A]Minimum compacted lift thickness: 6 inches. Maximum loose lift thickness: 8 to 9 inches.
[B]Allows compaction with small equipment.

F. In-place testing of soils shall be tested based on the following:

Table 02200.4	
In-Place Density Tests	
Soil Type/Classification	**Reference Standard**
GW, GP, GM, GC, SW, SP	• Sand Cone Method (ASTM D1556) • Nuclear Method ASTM D2922) [by percentage of Standard Proctor Density according to ASTM D 698]
SM, SC, ML, CL	• Sand Cone Method (ASTM D1556) • Rubber Balloon Method (ASTM D2167) • Nuclear Method ASTM D2922) • Drive-Tube Method (ASTM D2937) [by percentage of Standard Proctor Density according to ASTM D 698]

G. **Field Testing Limitations:**

1) When field density testing is incorporated according to Table 02200-1, subgrade adequacy is to be confirmed by proof rolling in the presence of the Engineering Director or his representative. In-place field density testing of the street or pad subgrade will not be required.

2) In-place field density tests of the roadway or pad subgrade in cut sections (excavation) is not required.

3) Testing/adequacy of intermittent undercut areas and repair areas (e.g., around manholes and boxes) that have been backfilled with select fill and compacted will be confirmed by proof rolling.

3.7 STRUCTURES: EXCAVATION, FILLING, AND BACKFILLING

A. **General**

See Section 02275 - *Trenching, Backfilling, and Compaction of Utilities* for excavation and backfilling for structures (manholes, catch basins, etc.). See

NCDOT *Standard Specifications for Roads and Structures, latest revision* for excavation and backfilling for retaining walls.

B. **Protective Measures for Structures**

1) **Drainage**: Control grading around structures so that the ground is pitched to prevent water from running into excavated areas or damaging structures. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water. Provide pumping required, keeping excavated spaces clear of water during construction. Should any water be encountered in the excavation, notify Engineering Director. Provide free discharge of water by trenches, wells, or other means as necessary and drain to point of disposal.

2) **Frost Protection**: Do not place foundations, footings, or fill material on frozen ground. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, footings or fill material can be placed immediately after excavation has been completed and approved. Protect excavation from frost if placing of concrete or fill is delayed.

3) **Protection of Structure:** Prevent new and existing structures from becoming **damaged** due to construction operations or other reasons. For catch basins, provide temporary weep holes with a non-woven filter fabric to relieve hydrostatic pressure on walls.

3.8 RIP RAP AND RIP RAP BEDDING PLACEMENT

Placement of Rip Rap and Rip Rap Bedding shall conform to Section 876 – *Rip Rap* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision.

3.9 PLACEMENT OF SOIL STABILIZATION FABRIC

Placement of soil stabilization fabric shall conform to the requirements of Section 270 – *Fabric for Soil Stabilization* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision and in accordance with the recommendations and directions of the Engineering Director and/or a Geotechnical Engineer for the application and use intended.

3.10 SUBSURFACE DRAINAGE SYSTEMS

See Section 2630 – *Storm Drainage* and Section 02275 – *Trenching, Backfilling, and Compaction of Utilities* for both materials and construction requirements regarding subsurface drainage systems

3.11 METHOD OF VOLUME MEASUREMENT

Contractors are required to furnish accurate counts of all excavation and/or fill moved which is to be paid for under a Contract unit price. The volumes shall be measured by either “truck tally” or by “cross-sectioning,” whichever method is approved by the Engineering Director or stated in the proposal and/or bid documents. When a truck count is used, the Engineering Director or their representative shall verify the count independently.

A. **Truck Tally Method:**

Excavation: When unclassified excavation or undercut volumes are to be counted by the truck tally method, "swell" is to be incorporated into the truck volume in the amount of 25%. Unless otherwise agreed to or justified by a Geotechnical Engineer, the following pay volumes are to be used for either unclassified or undercut excavation:

Tri-axle:	15 CY
Quad-axle:	19 CY

Borrow: When either off-site or on-site borrow is to be counted by the truck tally method, "shrinkage" is to be incorporated into the truck volume in the amount of 25% (shrinkage of truck volume placed compared to compacted fill volume) utilizing the following pay volumes:

Tri-axle:	12 CY
Quad-axle	14 CY

Loading Truck: A qualified truckload is one that is loaded up to within approximately 6" of the top of the dump bed, prior to dumping.

B. **Average-End-Method:**

Excavation and fill can be computed using the average-end-method. When used, this method is to be employed using the existing contours shown on the Contract Drawings and the Contractors actual surveyed finished contours (surveyed by a licensed Professional Surveyor). In so doing, the finished contours are to be plotted at the same scale as the original drawing and a transparency furnished to the Engineer for comparison to design grades. The volume computations are also to be submitted along with the Surveyors seal and a certification as to the volumes measured.

The Contractor, at his discretion and with the prior approval of the Engineer, may survey the "stripped" site (the site after topsoil has been removed) and compute the volumes based on the stripped site and the "designed" finished grade as shown on the Contract Drawings. As before, a transparency to the same scale and the Surveyors computations and certification are to be submitted to the Engineer for comparison and verification.

C. **Volume Formulas:**

Unless otherwise approved, the following formulas are to be used in computing cut and fill:

Fill Formula

Net Fill = Raw Fill Vol. – Unclassified Excavation X (1 - Shrink Factor) + Strip Vol. - Undercut or waste Fill placed in Fill Slopes X (1 - Shrink Factor) - Pavement Section or Building Floor Pad

Cut Formula

Net Cut = Raw Cut - Strip Vol. + Pavement Section or Building Floor Pad

3.12 CLEANUP AND RESTORATION OF SITE

A. During the progress of the work, the Contractor shall keep the premises and the vicinity of the work clear from unsightly and disorderly piles of debris. Suitable locations shall be specified for the various construction materials and for debris. The materials shall be kept in their storage locations, except as needed for the work and debris shall be promptly and regularly collected and deposited in the specified location.

B. Upon completion of grading operations, the Contractor shall fine grade the site, removing all surplus excavated material, leaving the area free from surface irregularities. He shall dispose of all surplus material, dirt, and rubbish from the site and shall keep the site free of mud and dust to the satisfaction of the Engineering Director. The Contractor may be required to flush or sprinkle the street to prevent dust nuisance.

C. When working on the shoulders of paved roads, the Contractor shall keep the pavement clean of all loose earth, dust, mud, grave, etc., and shall restore roadway shoulders and ditches as required by either the NCDOT or the right-of-way owner.

D. After all work is completed, the Contractor shall remove all tools and other equipment, leaving the site free, clean, and in good condition.

E. The Contractor shall keep the surface over and along the roadways and other graded areas in a safe and satisfactory condition during the progress of the work and for a period of one year after the work has been completed. He shall be held responsible for any accidents that may occur on the account of the defective condition of such surface.

3.13 SEEDING, SODDING, AND GROUNDCOVER

3.13.1 GENERAL

A. Seeding, Sodding, and Groundcover shall comply with the applicable provisions and requirements of Section 02920, *Seeding, Sodding and Groundcover*.

B. Seeding and groundcover includes seedbed preparation, liming, fertilizing, seeding, and mulching of all disturbed areas. Areas inside or outside the limits of construction that are disturbed by the Contractor's operation and activity shall be seeded and mulched.

Unless called for otherwise on the Erosion and Sedimentation Control Plan, in areas where natural sod or vegetation has been disturbed, the area shall be seeded in accordance with **Standard Detail 350.01**.

If the construction activity disturbed a landscaped lawn, the seeding shall be modified to restore ground cover comparable to the existing lawn.

C. Seeding shall be carried out as soon as practical after the construction in any one area and shall be maintained against erosion through the completion of the project. Seeding shall be accomplished as work progresses.

The Contractor shall be responsible for proper care of the seeded area during the period that vegetation is being established. In the event of an erosive rain before

an adequate stand of vegetation has been established, damaged areas shall be repaired, fertilized, seeded, and mulched at the Contractor's expense.

Seeding on rights of way of NCDOT maintained roads shall be in accordance with NCDOT specifications and the requirements of the approved encroachment permit.

D. **Vegetative Practices**:

1) Contractor to refer to and follow instructions on the NCG01 Ground Stabilization and Materials Handling plan sheet and the NCG01 Inspection, Record keeping, and Reporting plan sheet. Contractor to follow notes on those NCG01 sheets or as shown on plans, whichever is stricter.

2) Refer to Stabilization Timeframe Table.
Per NPDES Stormwater Discharge Permit for Construction Activities, NCG01, seeding shall be placed in the timeframes shown in the table below. The timeframes shown below govern over any other less stringent note on the plans or specifications for this contract.

Stabilization Timeframes Table

Site Area Description	Stabilization	Timeframe Exceptions
Perimeter Dikes, Swales, Ditches and Slopes	7 days	None
High Quality Water (HWQ) Zones	7 days	None
Slopes Steeper than 3:1	7 days	If slopes are 10' or less in length and are not steeper than 2:1, then 14 days are allowed
Slopes 3:1 or flatter	14 days	7 days for slopes greater than 50' in length
All other areas with slopes flatter than 4:1	14 days	None, except for perimeters and HQW Zones

3) Permanently seed areas that will not be re-disturbed. Do not allow any disturbed areas to remain disturbed any longer than necessary and do not remove protection devices until adequate ground cover has been achieved. Note that the time for establishment of permanent ground cover is 14 calendar days.

E. **Stockpile Area**: The Contractor is responsible for securing equipment storage, material lay down, and stockpile storage area for his work. As such, the Contractor is responsible for the necessary erosion control measures, including but not necessarily limited to, a construction entrance, silt fence, protection of streams/buffers, clean up and restoration of site to the satisfaction of the Town and the NCDEQ, Division of Energy, Mineral, and Land Resources, Erosion and Sediment Control Stockpile and/or waste areas must be maintained within the limits of the areas protected by the proposed measures and otherwise temporarily seeded if to be left stockpiled over 14 days.

3.14 MISCELLANEOUS

3.14.1 DUST CONTROL

A. Dust control is considered incidental and shall be carried out at the Contractor's expense.

B. **Conditions Where Practice Applies:** On construction roads, access points, and other disturbed areas subject to surface dust movement and dust blowing where off-site damage may occur if dust is not controlled.

C. **Design Criteria:**

1) Construction operations should be scheduled to minimize the amount of area disturbed at one time. Buffer areas of vegetation should be left where practical. Temporary or permanent stabilization measures shall be installed. No specific design criteria is given; see construction specifications below for common methods of dust control.

2) Water quality must be considered when materials are selected for dust control. Where there is a potential for the material to wash off to a stream, ingredient information must be provided to the Engineering Director or the applicable permitting authority.

D. **Construction Specifications**

1) Non-driving Areas: These areas use products and materials applied or placed on soil surfaces to prevent airborne migration of soil particles.

a. Vegetative Cover: For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control. See Section 13.3.1.D, above.

b. Mulch (including gravel mulch): Mulch offers a fast effective means of controlling dust. This can also include rolled erosion control blankets.

c. Spray adhesives: These are products generally composed of polymers in a liquid or solid form that are mixed with water to form an emulsion that is sprayed on the soil surface with typical hydroseeding equipment. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations for the specific soils on the site. In no case should the application of these adhesives be made on wet soils or if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators and others working with the material.

2) Driving Areas: These areas utilize water, polymer emulsions, and barriers to prevent dust movement from the traffic surface into the air.

a. Sprinkling: The site may be sprayed with water until the surface is wet. This is especially effective on haul roads and access routes.

b. Polymer Additives: These polymers are mixed with water and applied to the driving surface by a water truck with a gravity feed drip bar, spray bar or automated distributor truck. The mixing ratios and application rates will

be in accordance with the manufacturer's recommendations. Incorporation of the emulsion into the soil will be done to the appropriate depth based on expected traffic. Compaction after incorporation will be by vibratory roller to a minimum of 95%. The prepared surface shall be moist and no application of the polymer will be made if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators working with the material.

c. Barriers: Woven geotextiles can be placed on the driving surface to effectively reduce dust throw and particle migration on haul roads. Stone can also be used for construction roads for effective dust control.

d. Windbreak: A silt fence or similar barrier can control air currents at intervals equal to ten times the barrier height. Preserve existing wind barrier vegetation as much as practical.

3.14.2 SALVAGE OF USEABLE MATERIALS

All materials such as iron castings, paving blocks, brick, pipe and etc., removed during excavation that is useable on this project shall be used after approval of its use by the Engineering Director or the applicable owner of the street right-of-way. Such material shall be stockpiled on site. Unnecessary abuse and damage to these items shall be the Contractors responsibility and the cost of replacement may be deducted from the retainage.

End of Section 02200

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02275 - TRENCHING, BACKFILLING AND COMPACTION OF UTILITIES

(Last revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1- General
Part 2 – Products
Part 3 – Execution

Backfilling
Bedding Definitions
Bedding for Pipe
Blasting
Cleanup & Restoration

Clearing and Grubbing
Common Trench Backfill

Compaction – Min Require'ts
Def-Common Trench Backfill
Def-Select Earth Backfill

AirTestLine
DewateringDeflecttest
Dust Control
Erosion Control, NPDES
Flowable Fill Concrete,
Spec Foundation Preparation

TrenchW
Highway Crossings
Horizontal Direction Drilling

Marker Ball Spec
Minimum Pipe Cover
Pavement Repair

River & Creek Crossings
Rock Excavation
Seeding & Groundcover
Select Earth Backfill
Trench Backfilling

Unclassified Trench Excavation

PART 1 – GENERAL

1.1 GENERAL:

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to the furnishing, installing, and completing all operations associated with excavating, trenching, and backfilling of underground utilities as shown on the approved construction drawings and standard details and in accordance with provisions of these specifications and the Contract Documents

Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation, coordinated with the work of all related trades.

Work included in the project consists of, but is not necessarily limited to, methods of installation of the following:

1) Sanitary Sewer Pipe Installation & appurtenances.

2) Water Distribution Pipe Installation & appurtenances.

3) Storm Drainage Pipe Installation & appurtenance.

4) Removal and relocation of existing piping systems.

5) Buried Utility Structures

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The following operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

1) **AASHTO T99:** *Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.)*

2) **AASHTO T180:** *Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop*

3) **AASHTO M145:** *Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*

4) **AASHTO T191:** *Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method*

5) **AASHTO T205:** *Standard Method of Test for Density of Soil In-Place by the Rubber-Balloon Method*

6) **ACI PRC-229R-13(22)**: ACI Committee 229 *Report on Controlled Low-Strength materials*

7) **ASTM C33:** *Standard Specification for Concrete Aggregates*

8) **ASTM D698:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (Standard Proctor)*

9) **ASTM C1479**: *Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations*

10) **ASTM D1556:** *Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method*

11) **ASTM D1557:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (Modified Proctor).*

12) **ASTM D2167:** *Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method*

13) **ASTM D2321**: *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*

14) **ASTM D2487:** *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

15) **ASTM D2774**: *Standard Practice for Underground Installation of Thermoplastic Pressure Piping*

16) **ASTM D3740:** *Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*

17) **ASTM D4253**: *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*

18) **ASTM D4254:** *Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*

19) **ASTM D4318:** *Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*

20) **ASTM D7382**: *Standard Test Methods for Determination of Maximum Dry Unit Weight of Granular Soils Using a Vibrating Hammer*

21) **ASTM E329** *Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection*

22) **ASTM E548:** *Standard Guide for General Criteria Used for Evaluating Laboratory Competence*

23) **AWWA C600**: *Installation of Ductile-Iron Mains and Their Appurtenances*

24) **AWWA C605**: *Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings*

25) **AWWA M23**: *PVC Pipe – Design and Installation*

26) **UNI-PUB-06**: *Installation Guide for Solid-Wall PVC Sewer Pipe (4-15 inch; Clayton)*

27) **UNI-PUB-09**: *Installation Guide for Gasketed-Joint PVC Pressure Pipe*

C. Section 02510 – Water Distribution

D. Section 02530 – Sanitary Sewer

E. Section 02630 – Storm Drainage

F. Section 02920 – Seeding, Sodding, and Groundcover

G. NCDEQ, Division of Energy, Mineral, and Land Resources, *Erosion and Sediment Control Planning and Design Manual, latest revision*.

H. US Department of Labor, Occupational Safety and Health Administration (OSHA), Standard *29 CFR Part 1926, Safety and Health Regulation for Construction, Subpart P "Excavations,"* latest edition.

1.3 SUMMARY

A. This section includes:

1) Excavating and backfilling trenches for buried water, sewer, storm drainage, buried utility structures, and appurtenances.

2) Preparing subgrade for buried water and sewer, buried utility structures, and appurtenances.

B. Construction and materials related to this section but covered elsewhere:

1) Erosion Control: North Carolina Sediment Control Law.

1.4 DEFINITIONS

A. For the purposes of this specification, the following definitions refer to sanitary sewer, water distribution, and storm drainage systems that come under the authority of the Town of Clayton as specified within this section and other sections of this manual.

B. **Backfill**: Soil materials used to fill an excavated trench:

1) **Initial Backfill** (Carefully Compacted Select Earth Backfill): Backfill placed beside and over the top 12-inches of the pipe in a trench, including haunches to support sides of pipe.

2) **Final Backfill** (Common Trench Backfill): Backfill placed over the initial backfill to fill a trench.

C. **Bedding Course**: Layer of clean coarse stone placed over the excavated subgrade in a trench to bring the trench bottom up to grade before laying pipe.

D. **Classified Excavation (undercut)**: Classified excavation shall consist of the removal and satisfactory disposal of all unsuitable material located below subgrade elevation. Where excavation to the finished grade section results in a subgrade or slopes of muck, peat, matted roots, etc., the Contractor shall remove such material below the grade shown on the plans or as directed; and areas so excavated shall be backfilled with approved select fill or stone as ordered by the Engineering Director. See also paragraph S, Unclassified Excavation.

E. **Competent Person**: Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate the hazard.

F. **Engineering Director:** The Town's Director of Engineering or his or her authorized representative.

G. **Fire Marshall**: The Town of Clayton's appointed Deputy Chief/Fire Marshall responsible for Fire Code enforcement and investigating fires for origin and cause.

H. **Flowable Fill Concrete:**

1) **Definition**: Flowable-Fill, as described in the American Concrete Institute's (ACI) Committee 229 report, it is a Controlled Low Strength Material

(CLSM) used as primary backfill or alternate to standard soil or stone backfill. Flowable fill differs from Portland Cement Concrete as it contains a low cementitious content to reduce strength developments for possible future removal.

2) **Excavatable Flowable Fill Concrete**: An application where it may be necessary to remove the flowable fill at a later date.

3) **Non-Excavatable Flowable Fill Concrete**: An application where it is not necessary to remove or otherwise excavate the flowable fill at a later date.

4) **Applications**:

a. **Backfill**: Sewer Trenches, Utility Trenches, Bridge Abutments, Conduit Trenches, Pile Excavations, and Retaining Walls.

b. **Structural Fill**: Foundation Subbase, Subfooting, Floor Slab Base, and Pipe Bedding.

c. **Other Uses**: Abandoned Underground Storage Tanks, Wells, Abandoned Utility Company Vaults, Voids Under Pavement, Sewers and Manholes, and to contend with Muddy Conditions.

I. **Haunching:** Layer of clean coarse stone placed and compacted up to the springline of the pipe. Where voids may cause migration of native or backfill material, use well graded material without voids (coarse sands; SC, SM).

J. **Foundation Stone**: Clean well-graded stone, authorized by the Engineering Director, used to strengthen and/or provide support to an otherwise weak subgrade. Foundation stone is placed, and the subgrade improved before bedding stone is placed. Where voids may cause migration of native or backfill material, use well graded material with minimal to no voids (coarse sands; SC, SM or stone screenings) that would enable transport of fine-grained soils through the coarse stone foundation stone. See also Paragraph C, above for alternative corrective actions.

K. **Plans:** The approved plans, profiles, typical roadway or trench sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

L. **Rock Excavation for Trenches and Pits**: Rock excavation for trenches and pits includes removal and disposal off-site of materials and obstructions encountered that cannot be practically excavated with a track-mounted power excavator, equivalent to a Caterpillar Model No. 325 or equivalent equipped with new rock teeth. Practical excavation is defined as the ability to remove at least 30 cubic yards during one hour of continuous digging. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.

M. **Rock in Open Excavation**: Rock in open excavations includes removal and disposal on-site of materials and obstructions encountered in general excavation other than trenches and pits that cannot be dislodged and excavated with modern,

track-mounted, heavy-duty excavating equipment without drilling, blasting, or ripping. Rock is defined as material which cannot be effectively excavated during general grading with a D-8 or equivalent medium track-type tractor dozer drawing a new single-tooth ripper. Effective excavation is defined as the ability to remove 10 cubic yards or more of material after one hour of continuous ripping. Typical of materials classified as Rock in Open Excavation are boulders larger than 1-1/2 cubic yards or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

N. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

O. **Structures**: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

P. **Subgrade**: Surface or elevation remaining after completing the trench excavation or, the top surface of a backfill (stone or soil) immediately below the pipe conduit or pipe bedding, as applicable.

Q. **Topsoil**: See Division 02920 – *Seeding, Sodding, and Groundcover*.

R. **Trench Borrow**: Trench borrow shall consist of approved material imported from off-site for use as fill or backfill required to be placed in trenches either as initial carefully controlled select earth backfill or final common trench backfill. Trench borrow shall not be used until all suitable trench excavation material has been placed in the trench, unless authorized by the Engineering Director. Unless otherwise designated on the plans and in the contract documents, the Contractor shall make his own arrangements for obtaining borrow and pay all costs associated with obtaining borrow; including but necessarily limited to, borrow pit mining permits, Erosion Control at borrow source, excavation, transport, dumping, reclamation of pit, etc.

S. **Unclassified Excavation**: Removal and disposal of any and all material above subgrade elevation, except solid rock and undercut excavation, located within the limits of construction. See also paragraph D, Classified Excavation.

T. The following are industry abbreviation for various pipe materials:

1) **AC**: Asbestos Cement Pipe

2) **CAP**: Corrugated Aluminum Pipe

3) **CCFRPM**: Centrifugally Cast, Fiberglass-Reinforced Polymer Mortar Pipe

4) **CI**: Cast Iron Pipe

5) **DIP**: Ductile Iron Pipe

6) **HDPE**: High Density Polyethylene Pipe

7) **PCP**: Plain Concrete Pipe

8) **RCP:** Reinforced Concrete Pipe

9) **PVC**: Polyvinyl Chloride Plastic Pipe

10) **RCP**: Reinforced Concrete Pipe.

1.5 SUBMITTALS

A. Submit product data and a sample of drainage fabric or separation fabric and fully document each with specific location or stationing information, date, and other pertinent information.

B. **Material Test Reports**: Provided from a qualified testing agency which either indicate or interpret test results for compliance of the following requirements indicated:

1) Classification according to ASTM D2487 of each on-site or borrow soil proposed for backfill, unless otherwise directed by Engineering Director.

2) Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for backfill.

C. **Blasting**:

1) Insurance Certificate naming the Town as "additional Insured." See paragraph 3.8.1 – *Blasting* for other blasting insurance requirements.

2) Qualifications, proposed procedures, and schedule shall be submitted at least 2 weeks prior to commencing any blasting operations.

3) Permits from local Fire Department and Town officials. Coordinate with Deputy Chief/Fire Marshall.

4) Blasters shall, at all times, have their license and blasting permits on the job site, and shall allow examination of same by any official that may have jurisdiction.

5) If required by the Engineering Director, seismic survey agency report, for record purposes.

6) A pre-blast "existing conditions" survey may be required by the Town as part of the blasting permit to establish the pre-existing condition of structures (Residences, commercial properties, etc.) in close proximity to the blast site. The Engineering Director may require the pre-blast/post-blast surveys be performed by a Structural Engineer (a NC Licensed Professional Engineer). Coordinate with the Fire Marshall as well. See paragraph 3.8.2.J.

The Engineering Director or Fire Marshall may also request vibration/noise monitoring during blasting.

Contractor to maintain documentation on the existing conditions and post-construction conditions survey and provide to the Engineering Director upon request.

D. **Bury Depth Computations**: Computations justifying pipe bury when bury depth exceeds the allowable depth shown in this specification or as may be sown on the Standard Details. Provide method, applicable charts/graphs, printouts, assumptions, etc. used in justifying the adequacy of the pipe to withstand the loads imposed by the excessive depth.

E. **Product Data**:

1) Each type of plastic warning tape (Details 511.01 531.01, 531.02), marker balls (Details C01.04, 531.02), and fiberglass sewer marker post (Detail 539.01).

2) Stabilization/Separation fabric

3) Drainage Fabric

1.6 QUALITY ASSURANCE

A. **Geotechnical Testing Agency Qualifications**: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing as documented according to ASTM D3740 and ASTM E548. Testing Lab to be AMRL (AASHTO Materials Reference Laboratory) and CCRL (Cement and Concrete Reference Laboratory) certified.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

C. The contractor shall comply with North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, "*Erosion and Sediment Control Planning and Design Manual*," latest revisions.

F. Comply with applicable requirements of NFPA 495, *"Explosive Materials Code,"* latest revisions.

G. *"Gravity Sanitary Sewer Design and Construction*," (ASCE Manuals and Reports on Engineering Practice – NO. 60) (WPCF Manual of Practice NO. FD-5), latest revision.

H. Comply with Uni-Bell PVC Pipe Association "*Handbook of PVC Pipe: Design and Construction,"* 5th or latest edition.

1.7 REFERENCED STANDARDS ORGANIZATIONS

A. **AASHTO** American Association of State Highway Transportation Officials.

B. **ANSI** American National Standards Institute

C. **AREA** American Railway Engineering Association

D. **AREMA** American Railway Engineering and Maintenance-of-Way Association

E. **ASTM** American Society for Testing and Materials

F. **AWWA** American Water Works Association

G. **DWR** NCDEQ, Division of Water Resources

H. **FS** Federal Specifications

I. **MSDS** Material Safety Data Sheets

J. **NCDEQ** NC Department of Environmental Quality

K. **NCDOT** North Carolina Department of Transportation

L. **NPDES** National Pollutant Discharge Elimination System

M. **NSF** National Sanitation Federation International

N. **OSHA** Occupational Safety and Health Administration

O. **UL** Underwriters Laboratories, Inc.

1.8 TESTING SERVICES

A. The Testing Laboratory shall be selected by the Contractor, approved by the Engineering Director, and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirement of the Contract Documents and specifically note any deviation there from.

B. Specific test and inspection requirements shall be as specified herein.

1.9 PROJECT CONDITIONS

A. **Demolition**: Demolish and completely remove from the site existing underground utilities indicated on the plans to be removed.

B. Environmental - Wetlands: Before crossing or entering into any jurisdictional wetlands, contractor shall verify whether or not a wetlands permit has been obtained for the encroachment and whether special restrictions have been imposed. Care shall be taken to prevent draining or otherwise destroying non-permitted wetlands. Restore as stated on either the project drawings, the contract documents, and/or as noted in the permit. All crossings, disturbances, and encroachments into wetlands shall be subject to US ACOE and NCDEQ Division of Water Resources (DWR) approval and permitting requirements and conditions.

C. **Environmental - Buffer Crossing Requirements:** Before crossing streams or ditches or working within 50 feet of ponds, lakes, or rivers, the Contractor shall

verify whether either the line is exempt or a permit has been obtained to encroach into a nutrient sensitive stream or river basin buffer and if so, to what extent work is permitted to occur. Unless otherwise permitted, shown on the contract drawings, or exempted by NCDEQ or other proper authority, water and sewer crossing stream, river, pond, or lake buffers are to be as near perpendicular as possible (the crossing is considered to be perpendicular if it intersects the stream or surface water between an angle of 75 and 105 degrees). Do not disturb more than 40 linear feet (longitudinal) of riparian buffer. When permitted to encroach into zone 1 (the lower 30 feet beside the stream or water), adhere to all of the following Best Management Practices in during construction.

1) Woody vegetation is cleared by hand. No grading allowed.
2) Stumps to remain except in trench where trees are cut. Minimize disturbance to roots in buffer zone.
3) Set aside topsoil and replace to existing grade immediately after backfilling.
4) Backfill trench with the excavated soil immediately following installation.
5) Do not use fertilizer except for the one-time application to reestablish vegetation.
6) Minimize removal of woody vegetation, the amount of disturbed area, and the time the disturbed area remains disturbed.
7) Take measures to ensure diffuse flow of water through the buffer after construction.
8) In wetland areas, use mats to minimize soil disturbance.
9) Remove the existing topsoil to a depth of 6 inches or to the depth encountered from all areas in which excavation will occur. The topsoil shall either be stored in stockpiles separate from the excavated trench material if the topsoil is to be respread or otherwise disposed of off-site. Topsoil stockpiles shall be graded to freely drain surface water, and shall have a silt fence placed around the base of the stockpile.

D. See also **Standard Detail C01.05** for other Minimum Separation of Utilities and Other Features requirements.

E. **Safety**

The contractor shall keep the surface over and along the trenches and other excavation in a safe and satisfactory condition during the progress of the work.

1.10 CROSS-CONNECTION CONTROL

Refer to Town of Clayton Cross-Connection/Backflow Protection Ordinance (Town Code, Title V: Public Works, Chapter 53) latest adoption as applicable. See Section 02510, Water Distribution, paragraph 2.2.2, for Backflow Prevention device specifications.

1.11 SERVICE INTERRUPTION

Contact the Town of Clayton to coordinate interruption of service, operation of valves, line cut-ins, or placement of a tapping sleeve and valve. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Engineering Director, temporary service

may be required to be provided. Provide a minimum of 72 hours' notice of the proposed utility interruption or necessary operation of valves.

1.12 COORDINATION

A. Coordinate tie-in to municipal water mains with the Engineering Director. Except as needed for fire suppression purposes, the Town of Clayton will be the sole operator of all valves and hydrants on the Town's water distribution system. Adequate notifications to water customers will be given by the Contractor prior to any interruption of service. Service is to be continuously maintained to customers in the project areas except for the minimum amount of time required to make connections with the existing system. Only in the case of an emergency may a valve be closed by a Contractor. Records shall be kept of any valves closed during an emergency and the Engineering Director shall be notified of the specific valves closed at the earliest reasonable time following such valve closure.

   Before shutting off any main, residents are to be notified by the Town of Clayton's representative in writing at least 24 hours in advance of cut off. The Contractor shall provide assistance to the Town in notification distribution. The Town shall be notified at least 48 hours in advance of request for operation of valves and making either a wet tap or cut-in.

B. Coordinate tie-in to municipal sewer mains and manholes with the Engineering Director.

C. At the direction of the Engineering Director, temporary pumping/bypass of sewerage flow may be required to be provided. See Section 02530 - *Sanitary Sewer*, *Bypass Pumping* for by pass pumping requirements and procedure.

D. When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks' notice prior to anticipated disturbance or interruption. At the discretion of the Engineering Director, the notice may be required to be published in the newspaper.

E. **Repair of pavement markings**: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.

F. **Water Service Shut-off**

   The Town of Clayton requires adherence to the following procedures prior to shutting off water service on any existing Town line:

   1) The Contractor must receive approval for shut-off from the Engineering Director. Generally, shut-offs must occur from 9:00 AM to 11:00 AM and 2:00 PM to 4:00 PM on weekdays.

   2) After receiving approval, Contractor shall notify affected residents in writing 48 hours in advance of beginning operation.

G. Before Digging, contact ***"NC One Call"*** at 811 and the Town of Clayton at 919-553-1530 for location of services.

1.13 PUBLIC CONVENIENCE

The contractor shall at all times so conduct his work as to ensure the least possible inconvenience to the general public and the residents in the vicinity of the work. Fire hydrants on or adjacent to the work shall be kept accessible to firefighting equipment at all times. Temporary provisions shall be made by the Contractor to ensure the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches, which shall not be obstructed except as approved by the Engineering Director.

1.14 TRAFFIC CONTROL

A. When working within any NCDOT System road or highway, conform to the *Manual on Uniform Traffic Control Devices*, latest revision (MUTCD) as well as the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

B. Traffic Maintenance shall comply with the latest revision of the NCDOT *Standard Specifications for Roads and Structures*, Division 9 – *Signing* and Division 11 – *Work Zone Traffic Control*, as well as other applicable sections.

C. A traffic control plan shall be submitted to the Town of Clayton Police Department and NCDOT (if applicable) for approval.

D. When traffic signals or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the NCDOT or the Engineering Director. Provide 1 weeks' notice prior to anticipated disturbance or interruption.

E. Whenever it becomes necessary to leave a section of trench open after completion of the days' work, the contractor shall provide barricades and lights to protect the public. Operate warning lights during hours from dusk to dawn each day and as otherwise required for inclement weather and visibility.

1.15 EROSION AND SEDIMENTATION CONTROL AND NPDES MONITORING, CONTROLS, AND LIMITATIONS FOR PERMITTED DISCHARGES

The Project Engineer shall submit a sedimentation and erosion control plan and permit application to the Town of Clayton and obtain all necessary construction permits. The Contractor shall follow all local and state requirements regarding sedimentation and erosion control. Construction methods shall minimize sedimentation and erosion.

The compliance program is a self-monitoring program. It is the Contractor's responsibility to periodically monitor the Stormwater Discharge Outfall points at the specified frequency and maintain reports as outlined in these specifications.

A. **Final Limitations and Controls for Stormwater Discharges**

During the period beginning on the effective date of the permit and lasting until expiration, the Owner (Permittee) is allowed and authorized to discharge stormwater associated with construction activity. Such discharges shall be controlled, limited, and monitored as specified below.

1) The Contractor shall implement the Erosion & Sedimentation Control plan, which has been approved by the approval authority. The approved plan is considered a requirement or condition of the general NPDES permit. Deviation from the approved plan, or approved amendment to the plan, shall constitute a violation of the terms and conditions of this general permit except that deviation from the approved plan will be allowed:

   a. To correct an emergency situation where sediments are being discharged off the site, or

   b. When minor modifications have been made for the purpose of improving the performance of the erosion and sedimentation control measures and notification of the minor modification has been made to the Town of Clayton.

   Such a deviation from the approved plan shall be noted on the approved plan maintained at the job site. During active construction, a copy of the approved plan shall be maintained on the site.

2) Equipment utilized during the construction activity on a site must be operated and maintained in such a manner as to prevent the potential or actual pollution of the surface or ground waters of the state. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not be discharged onto the ground or into surface waters. Spent fluids shall be disposed of in a manner so as not to enter the waters, surface, or ground, of the state and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in a manner so as not to allow their entry into the waters, surface or ground, of the state.

3) Herbicide, pesticide, and fertilizer usage during the construction activity shall be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act and shall be in accordance with label restrictions.

4) All wastes composed of building materials shall be disposed of in accordance with North Carolina General Statutes, Chapter 130A, Article 9 – *Solid Waste Management*, and rules governing the disposal of solid waste (North Carolina Administrative Code Section 15A NCAC 13B – *Solid Waste Management).*

5) The Contractor, for the Permittee, shall control the management and disposal of litter and sanitary waste from the site such that no adverse impacts to water quality occur.

B. **Minimum Monitoring and Reporting Requirements**

Minimum monitoring and reporting requirements are as follows unless otherwise approved in writing by the Director of the Division of Water Resources.

1) All erosion and sedimentation control facilities shall be inspected by or under the direction of the permittee (the Owner and his/her Contractor). Inspections shall be made:

   a. At least once every seven calendar days (at least twice every seven (7) days for those facilities discharging to waters of the State listed on the latest EPA approved 303(d) list[1] for construction related indicators of impairment such as turbidity or sedimentation),

   b. And within 24 hours after any storm event of greater than 0.5 inches of rain per 24-hour period.

      A rain gauge shall be maintained on the site by the Contractor and a record of the rainfall amounts and dates shall be kept by the Contractor. Submit with each payment request.

2) Once land disturbance has begun on the site, stormwater runoff discharges shall be inspected by observation for stormwater discharge characteristics as defined below at the frequency in stated above to evaluate the effectiveness of the pollution control facilities or practices. If any visible sedimentation is leaving the disturbed limits of the site, corrective action shall be taken immediately to control the discharge of sediments outside the disturbed limits.

Stormwater Discharge Characteristics	Monitoring Type[1]	Monitoring Location[2]
Clarity	By observation	SDO
Floating Solids	By observation	SDO
Suspended Solids	By observation	SDO
Oil Sheen	By observation	SDO
Other obvious indicators of stormwater pollution	By observation	SDO

Footnotes:
[1] Monitoring Type: The monitoring requires a qualitative observation of each stormwater outfall. **No analytical testing or sampling is required**.
[2] Sample (observation) location: **SDO**= **S**tormwater **D**ischarge **O**utfall

3) The operator (Contractor) shall keep a record of inspections and forward copies of these reports to the Engineering Director. Visible sedimentation found outside of the disturbed limits shall be recorded and a brief explanation kept with the records as to the measures taken to control future releases. Any measures taken to clean up the sediment that has left the disturbed limits shall also be recorded. These records shall also be made

[1] *The latest approved list may be obtained from the Division of Water Resources, or from the following website location:* https://deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment/water-quality-data-assessment/integrated-report-files

available to DWQ or an authorized agent upon request. If the Engineering Director or his/her representative discovers sedimentation outside the limits of disturbance, the Contractor will be notified in writing and requested to remediate the situation.

4) All records of monitoring shall be turned over to the Town along with the "red lined" record water and/or sewer drawings.

C. **Schedule of Compliance**

1) The Contractor shall comply with Final Limitations and Controls specified for stormwater discharges once disturbance has begun on the site and until completion of construction or development and the establishment of a permanent ground cover.

2) During construction and until the completion of a construction or development and the establishment of a permanent ground cover, the Contractor shall provide the operation and maintenance necessary to operate the stormwater controls at optimum efficiency.

PART 2 – PRODUCTS

2.1 SOIL, BEDDING AND BACKFILL

2.1.1 MATERIAL CLASSIFICATION

A. **Bedding Material**: NCDOT #57 or #67 stone.

B. **Excavation**: All excavation material shall be classified as either Rock or Unclassified Earth Excavation. Prices bid for the various sizes of pipe shall include excavation and backfilling.

C. **Flowable Fill Concrete Backfill** (Controlled Low Strength Material): See Section 1,4, Definitions, paragraph H.

1) **Excavatable**: To be excavatable by machine equipment, concrete strength shall be liquid enough to flow, be self-leveling, excavatable, and have a minimum 28-day compressive strength of 30 psi but not more than 100 psi (150 psi max at 56 days). Non-vibrated Slump: Flowable.

2) **Non-Excavatable**: Non-excavatable flowable fill concrete shall have a minimum 28-day compressive strength of 125 psi but no more than 200 psi. Materials shall comply with the recommendations within chapter 3 of ACI 229, latest revision, which include cement, aggregates, fly ash, water, admixtures, slag, and other nonstandard materials. Non-vibrated Slump: Flowable.

D. **Foundation Stone**: Foundation/Trench Stabilization Material: #67 or #57 stone.

E. **Select Earth Backfill**: Select earth backfill shall be free of debris, roots, frozen materials, organic matter, rock, or gravel larger than 1 inch in any dimension, or

other harmful matter and shall generally meet *NCDOT Standard Specifications for Roads and Structures*, Section 1016 – Select Material for properties and gradation. Select materials may be specified for use in subgrade, backfill in undercut, foundation conditioning, pipe backfill, material placement over fabric, etc.

F. **Common Trench Backfill**:

1) **Satisfactory Soils**: ASTM D2487 soil classification group (Unified Soil Classification System) GW, GP, GM, GC, SW, SM, SC, ML, and CL or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste frozen materials, vegetation, and other deleterious matter.

2) **Unsatisfactory soils**: ASTM D 2487 soil classification group CH (Fat Clay), MH, OH, OL and PT; soils which contain rock or gravel larger than 3 inches in any dimension, topsoil, debris, debris-laden fill, waste frozen materials, organic materials/vegetation, clumps of clay larger than 3 inches in any dimension, and other deleterious matter. Unsatisfactory soils also include satisfactory soils not maintained within +/- 3% of optimum moisture content at time of compaction, unless otherwise approved by the Engineering Director.

G. **Structures, Backfill Around**: Backfill shall be approved by the Engineering Director and shall be free from large or frozen lumps, wood, or rocks more than 3 inches in their greatest dimension or other extraneous material. Top 12" to be free of material greater than 1". Porous backfill shall be either #67 or #57 clean stone.

H. **Topsoil**: Topsoil shall consist of friable clay loam, free from roots, stones, and other undesirable material and shall be capable of supporting a good growth of grass. Topsoil shall be free of material greater than 1-inch in any dimension. See 02920 – Seeding, Sodding, and Groundcover.

2.1.2 PIPE BEDDING DEFINITIONS

A. **Pipe Bedding Definitions**

1) **Class D Bedding** is that condition existing when the ditch is excavated slightly above grade by excavation equipment and cut to finish grade by hand. Bell holes are dug, to prevent point loading the pipe bells, so that pipe bears uniformly upon the trench bottom. Existing soil should be shovel sliced or otherwise compacted under the hunching of the sewer pipe to provide some uniform support. Soil is tamped to 90% of the maximum Standard Proctor dry density around the pipe to a point one foot above the pipe. The remainder of the soil to the ground surface is to be compacted to the density specified in Table 2275.3. In poor soils, granular bedding material is generally a more practical, cost effective installation. The bedding factor for class D bedding is 1.1.

2) **Class C Bedding** is that condition where the sewer pipe is bedded in compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside sewer pipe diameter, but not less than 4 inches or more than 6 inches, and shall extend up the sides of the sewer pipe one-sixth of the pipe outside diameter. The remainder of the side fills, to a minimum depth of 6 inches over the top of the pipe, consists of lightly

compacted backfill. The remainder of the soil to ground surface is to be compacted to the density specified in Table 2275.3. The bedding factor for class C bedding is 1.5.

3) **Class B Bedding** is that condition where the sewer pipe is bedded in carefully compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside sewer pipe diameter, but not less than 4 inches or more than 6 inches, between the barrel and the trench bottom, and covering the full width of the trench.

   The haunch area of the sewer pipe must be fully supported; therefore, the granular material should be shovel sliced or otherwise compacted under the pipe haunch to the springline of the pipe. Both granular haunching (to the springline) and initial backfill to a minimum depth of 12 inches over the top of the sewer pipe should be placed and compacted. The initial backfill material, to a depth of 12 inches over the top of the pipe, should be compacted to no less than 90% of the maximum Standard Proctor dry density. The remainder of the soil to the ground surface is to be compacted to the density specified in Table 2275.3. The bedding factor for class B bedding is 1.9.

4) **Class B-1 Bedding** (*PVC pipe applications*) is the same as Class B Bedding except that granular backfill is placed to the ***top of the pipe*** rather than to the springline of the pipe. The remainder of the soil to the ground surface is to be compacted to the density specified in Table 2275.3.

5) **Class A Bedding** is that condition when the sewer pipe is bedded in a cast-in-place cradle of either plain or reinforced concrete having a thickness equal to one-fourth the inside pipe diameter, with a minimum of 4 inches and a maximum of 15 inches under the pipe barrel and extending up the sides for a height equal to one-fourth the outside pipe diameter. The cradle width shall have a width at least equal to the outside diameter of the sewer pipe barrel plus 8 inches. The bedding factor for class A bedding is 2.2.

   The haunching and initial backfill material above the concrete cradle should be crushed stone or a well graded granular material and carefully compacted to 12 inches above the crown of the sewer pipe. The remainder of the soil to the ground surface is to be compacted to the density specified in Table 2275.3.

2.2 MISCELLANEOUS

2.2.1 GEOTEXTILE FABRIC

Geotextile fabric shall be protected from mud, dirt, dust, sunlight, and debris during transport and storage. Material shall be inert to commonly encountered chemicals; resistant to mildew, rot, insects, and rodents; and biologically and thermally stable. Geotextile fabric for subsurface installation shall not be exposed to direct sunlight for more than 24 hours before or during installation.

A. **Filter Fabric for Rip Rap**: Filter Fabric for Rip Rap and Rip Rap Beddings shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for **Type 2** geotextiles for filtration geotextiles.

B. **Soil Stabilization Fabric**: Generally, soil stabilization fabric shall conform to the requirements of Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for **Type 4** geotextiles for stabilization geotextiles. However, provide fabric meeting Geotechnical Engineers recommendations for the application and use intended.

C. **Fabric for Subsurface Drains**: Non-woven needle-punched fabric shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for **Type 1** geotextiles for subsurface drain geotextiles.

D. **Silt Fence Fabric**: Silt fence fabric shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and* **Structures**, latest revision for Type 3 geotextiles for silt fence geotextile fabric, Class A or B as specified or shown on the plans.

2.2.2 WARNING TAPE

Metallic Underground Warning Tape: Metallic detectable underground warning tape shall consist of a solid aluminum foil core, minimum 0.35 mil foil thickness, encased on each side with plastic (minimum overall thickness 5 mils) and be 3 inches wide with black lettering imprinted on a color-coded background that conforms to APWA uniform color code specification (BLUE) and silver with black ink letters. Minimum tensile strength shall be 22 lbs./inch. Soil tolerance range to be pH 2.5 to pH 11.0. On one side of the tape, the text shall include the wording "WATER (or a SEWER force main, if applicable) LINE BELOW" repeated along the length of the tape. A detectable warning tape shall be used with all water and sewer force mains. See **Standard Details 511.01, 531.01, 531.02,** and **531.03**.

See **Pre-Approved Product List** for approved manufacturers and product numbers.

Standard color code for tape and wire.

Blue:	Water Systems
Green:	Sewer Systems

2.2.3 LOCATOR WIRE (To be installed when directed by the Engineering Director)**:**

#12 AWG blue insulated solid copper wire to be installed as directed by the Engineering Director. Electrical conductivity along the pipe shall be continuous and uninterrupted between valve boxes. When locator wire is required for pipe, clamps used to bond wire to conductor to metal (in instances where both PVC and ductile iron are used in the same run of pipe) shall be heavy-duty stainless steel approved by the Engineering Director.

2.2.4 RFID* Marker Balls with iD Read/Write

*(Radio Frequency ID)

A. 4-inch diameter self-leveling programmable, water-tight polyethylene, passive location marker, bury depth range: 5 ft depth, 100 to 200 ft spacing linearly. Works without any external power source. The locator transmits a signal to the buried

marker and the marker returns the signal to the locator, indicating the marker's exact position. Marker must be capable of integrating with GIS system.

B. Refer to **Standard Detail C01.04** for spacing/location of marker balls. Confirm bury limitations as well as spacing/location of marker balls with marker ball manufacturers recommendations.

C. **Utility type**: General Purpose, Reclaimed Water, Potable Water, Wastewater, color coded to APWA standards.

D. See **Standard Detail C01.04** for both a diagram and General Recommendations for marker bury and placement.

E. See **Pre-Approved Product List** for approved manufacturers and models.

2.2.5 DEFORMED REINFORCING STEEL

Reinforcing Steel bars shall meet ASTM A615, grade 60, latest revision.

2.2.6 WELDED WIRE FABRIC

Welded wire fabric shall meet ASTM A185, latest revision.

2.2.7 PERMITS

See Sections 1.9 Project Conditions, 1.12 Coordination, 1.14 Traffic Control and 1.15 Erosion & Sedimentation Control, above for permitting requirements.

PART 3 – EXECUTION

3.1 PREPARATION

3.1.1 GENERAL REQUIREMENTS APPLYING TO ALL AREAS

A. Contractor shall plan construction to minimize disturbance to properties adjacent to the water or sewer lines.

B. The Engineering Director reserves the right to limit the width of land to be disturbed and to designate on the drawings or in the field certain areas or items within this width to be protected from damage.

C. **Access and/or Haul Roads**: Any grading or excavation required for equipment travel during the course of construction as well as erosion control, access or haul road removal, restoration, seeding and ground cover shall be provided by the Contractor.

D. The Contractor shall be responsible for damage to areas or items designated by the Engineering Director to be protected. Repairs to, replacement of, or reparations for areas or items damaged shall be made to the satisfaction of the Engineering Director and affected property owners before acceptance of the completed project.

E. The Contractor shall protect all buildings or structures located along the utility line. Hand trenching, shoring, or other methods may be required.

F. Any fences disturbed by the Contractor shall be repaired to a condition equal to or better than their original condition or to the satisfaction of the Engineering Director. This may require the use of new material.

G. Contractor shall limit width of disturbed area through garden areas to a width absolutely necessary for construction of utility line.

H. Contractor shall obtain written permission from property owners for use of any access other than ones located within public rights-of-way or easements. Written permission shall contain conditions for use and restoration agreements between property owner and Contractor.

I. All areas disturbed shall be restored to a condition equal to or better than their original condition and shall be graded to drain.

J. The Contractor shall replace or repair all damaged or destroyed hedgerows and property corners using the services of a licensed Professional Surveyor.

3.1.2 CONSTRUCTION LIMITS

A. Contractor shall not disturb any areas outside the limits contained in this section without express written permission from the Engineering Director.

B. Except as indicated on the plans, no “clear cutting” of timber shall be permitted within the construction limits. Contractor shall make select cutting of trees, taking smallest trees first, that are mandatory for the construction of the utility line. The decision of the Engineering Director shall be final on the determination of which trees are to be cut.

C. The widths measured from the centerline of the water or sewer lines shall be as shown on the contract drawings. The Contractor shall protect all areas outside these construction limits unless written variations are granted by the Engineering Director.

D. **Specific requirements applying to developed subdivision/lots**

1) Unless otherwise noted/indicated on the project plans, all trees located beyond 15 feet of the centerline of water or sewer line shall be protected by the contractor. The Engineering Director reserves the right to designate other trees located closer to the centerline for protection where possible.

2) All shrubs, hedges, or other ornamental plantings located along the line shall be protected or removed and replanted by the Contractor, and survival guaranteed through the project’s warrantee period. If the plantings fail to survive, they shall be replaced with specimens of like size whenever available.

3) The contractor shall protect septic systems or springs located beyond 15 feet from the centerline of the line. Any septic system damaged by the Contractor will be maintained and pumped by the Contractor until it is

repaired to the satisfaction of the County Department of Environmental Health or the property is connected to the sanitary sewer.

4) Contractor shall grub only brush, roots, and stumps of removed trees. Damage to lawns shall be kept to an absolute minimum necessary for construction.

5) Excavated or blasted rock shall be removed from the site unless otherwise ordered by the Engineering Director.

6) Restoration and fine grading shall follow within 15 calendar days from the time an area is disturbed or within 1,000 feet from the immediate work site, whichever occurs first. Seeding shall follow as ordered by the Engineering Director.

E. **Specific requirements applying to undeveloped areas**

1) In wooded areas, the clearing shall be 15 feet on each side of pipe, unless indicated differently on the Town of Clayton approved construction drawings, in which case, the work shall be confined to the limits defined on the plans. All permanent easements shall be fully cleared. On Town funded projects, all trees 12 inches in diameter or larger located beyond 15 feet of the centerline of the water or sewer line shall be protected unless Contractor obtains written authorization from the Engineering Director to remove them. The Engineering Director reserves the right to designate select trees located closer to the centerline for protection where possible.

2) In areas where livestock and pets are kept, the Contractor shall notify property owner prior to commencing work and keep owner advised of progress of work. Fences shall be kept secure at all times and livestock and pets protected from open ditches, machinery, blasting, and other hazards.

3) Restoration, fine grading, and permanent seeding shall follow within 15 working days or 30 calendar days, whichever is shorter, from the time an area is disturbed. Trench disturbance shall not exceed more than 1,000 feet from the immediate work site without the approval/consent of the Engineering Director. See 02920 - Seeding and Groundcover.

F. **Other Minimum Lateral Offset Requirements:**

1) See **Standard Detail C01.05**, sheet 5 of 6 for other sanitary sewer lateral minimum offset requirements.

3.1.3 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. **Subsurface obstructions**

1) **Subsurface obstructions**: Take necessary precautions to protect existing utilities from damage due to any construction activity. The Contractor shall locate existing utilities, culverts, and structures (above or below ground), before any excavation starts and coordinate work with utility companies. The Contractor shall be responsible for notifying utility companies when working within the vicinity of the existing utilities. Omission from or

inclusion of located utility items on plans do not constitute non-existent or definite location. Even though for convenience, the utility may be shown on the plans, the Contractor is responsible for and shall call for utility location a minimum of 48 hours prior to excavations. Contact underground damage protection services NC One Call at 1.800.632.4949 and Town of Clayton at 919.553.1530. Secure and examine local utility surveyor records for available location data including building service lines.

2) Unless shown to be removed, protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to trenching. In excavating, care must be taken not to remove or injure any subsurface structure. All existing gas pipes, water pipes, steam pipes, telephone lines, cable TV lines, electrical conduits, sewers, drains, fire hydrants, and other structures which, in the opinion of the utility company, do not require relocation shall be carefully supported, shored up, the flow maintained, if applicable, and the line/main protected from damage by the Contractor. If damaged, the Contractor shall give immediate notice to the proper authorities. The utility shall be restored, at the Contractor's expense, by the appropriate utility to original or better condition. Where pipes, conduits, or sewers are removed from the trench leaving dead ends in the ground, such ends shall be carefully plugged or bulkheaded by the Contractor at the Contractor's expense. The Contractor shall be responsible for any damage to persons or property caused by such breaks.

3) The Contractor shall be responsible for anticipating and locating underground utilities and obstructions. When construction appears to be in close proximity to existing utilities, the trench(es) shall be opened a sufficient distance ahead of the work or test pits made to verify the exact locations and inverts of the utility to allow for changes in line and grade.

4) If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.

5) Should it become necessary to move the position of any underground structure, when approved by the Engineering Director or, the Contractor may be required to do such work and shall be paid on a force account basis or on an extra work basis.

6) If existing utilities are found to interfere with the permanent facilities being constructed, immediately notify the Engineering Director and secure further directions/instructions.

7) Do not proceed with permanent relocation of new or existing utilities until written instructions are received from the Engineering Director.

B. **Protection of Surface Features**

1) Whenever the utility line is to be placed in or near a paved street, the Contractor shall provide pads or take necessary precautions to protect the pavement from damage by the construction equipment. Pavement damaged by cleated or tracked equipment, or by any other means, shall be repaired by the Contractor at his expense.

2) Where a utility line is in an existing paved area, the Contractor shall use care to cut in sharp, neat lines ahead of the excavating/ditching equipment and parallel to the pipe on each side as may be applicable. If the existing road to be cut is located within another jurisdiction other than the Town of Clayton or within NCDOT rights of way, the Contractor is responsible for contacting the local representative or NCDOT, respectively about pavement repair/replacement.

3) Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property.

4) Provide full access to public and private premises, to fire hydrants, at street crossings, sidewalks and other points as designated by the Engineering Director to prevent serious interruption of travel.

5) Protect and maintain benchmarks, monuments, or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of the Engineering Director and the jurisdictional agency.

C. **Procedures for repairing damaged utility services**

1) If a located service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Town.

2) **House services**: If a service pipe supplying water or gas to an adjoining house is broken, the Contractor shall repair it at once and at his expense. The Town may, at the Contractor's expense, repair any such service without prior notice to the Contractor.

3) **Gas Service/Main Repairs**: Unless licensed to perform gas related service/pipe repairs, Contractor is not to perform any gas related work. Contact either the owner's propane gas provider or Piedmont Natural Gas, as applicable, for repair. Take the necessary measures required to protect the public and homeowner(s) immediately if the break or leak is due to a damaged gas main; the latter case requiring immediate contact of both the Town of Clayton Police and Fire Departments.

3.1.4 PROTECTION OF PERSONS AND PROPERTY

A. Barricade open holes and depressions occurring as part of the work, and post warning lights on property adjacent to or part of public access.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this or other related sections.

C. **Protection and Restoration of Property:** The contactor shall not enter upon private property for any purpose without first obtaining permission. He shall use every precaution necessary to prevent damage or injury to any public or private property, trees, fences, monuments, and underground structures, etc., on and

adjacent to the site of the work. He shall protect carefully from disturbance or damage all land monuments and property markers until an authorized agent has witnessed or otherwise referenced their locations, and shall not remove them until directed.

The Contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect, or misconduct in his manner or method or executing said work, from his nonexecution of work, or from defective work or materials, and he shall not be released from said responsibility until the work shall have been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, he shall restore such property, at his own expense, to a condition equal to or better than that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring, and may be directed or he may make good such damage or injury in an acceptable manner.

The Contractor shall, at his own expense, sustain in their places and protect from direct or indirect injury all pipes, poles, conduits, walls, roadways, buildings, and other structures, utilities and property in the vicinity of his work. Such sustaining and supporting shall be carefully employed by the Contractor and as required by the Company or party owning the structures or Agency controlling it. The Contractor shall take all risks attending to the presence or proximity of pipes, poles, conduits, walls, thereof and any costs associated will be deducted from any monies due the Contractor. Failure of the Engineering Director or his/her authorized representative to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.

3.1.5 CLEARING AND GRUBBING

A. **Description**: This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, as designated on the plans or as required by the Engineering Director. The work shall also include the preservation from injury or defacement of all vegetation or objects designated to remain. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, down timber, brush, rocks, projected roots, stumps, rubbish, laps, and other material within easement.

B. A preconstruction meeting shall be held with appropriate urban forestry personnel and the Town prior to any clearing, if required. The Engineering Director may require tree protection fencing in sensitive areas, where specifically identified trees are desired to be protected, and when required by the landscape ordinance.

C. The Contractor shall provide barricades, fences, coverings, or other types of protection necessary to prevent damage to existing improvements, not indicated to be removed, and improvements on adjoining property. All improvements damaged by this work shall be restored to their original condition and to a condition acceptable to the owner or other parties or authorities having jurisdiction. Trees and shrubs that are to remain within the construction limits will be indicated on the drawings or conspicuously marked on site. Unless otherwise noted, trees within

the construction limits shall become the property of the Contractor and shall be removed from the site.

D. Contractor shall protect existing tress and other vegetation indicated by the Engineering Director to remain in place against limb, bark or root damage such as cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. When such damage does occur, all rough edges of scarred areas shall be removed in accordance with accepted horticultural practices.

E. Carefully and cleanly, cut roots and branches of trees indicated to remain where the roots and branches obstruct construction of the utility line. If directed by the Engineering Director, the Contractor shall provide protection for roots and branches over 1 ½ inches diameter that are cut during construction operations. Coat the cut faces with emulsified asphalt, or other coating especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out. Provide earth cover as soon as possible.

F. Trees and vegetation designated to remain shall be repaired or replaced at Contractor's expense in a manner acceptable to the Engineering Director if they are damaged by construction operations. Repair tree damage as directed by a qualified tree surgeon.

G. Debris from the site shall be removed in such a manner as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, dust, and debris at all times.

H. The method of stripping, clearing, and grubbing the site shall be at the discretion of the Contractor. However, all stumps, roots and other debris protruding through the ground surface or in excavated areas shall be completely removed and disposed of off the site by the Contractor.

I. **Stripping of Topsoil**: Remove the existing topsoil to a minimum depth of 6 inches, or to the depth topsoil is encountered, from all areas in which excavation will occur. The topsoil shall either be stored in stockpiles separate from the excavated trench material if the topsoil is to be respread or otherwise disposed of off-site. Topsoil stockpiles shall be graded to freely drain surface water, and shall have a silt fence placed around the base of the stockpile.

J. **Disposal**: All brush, treetops, stumps, and debris shall be hauled away from site or otherwise disposed of in a manner acceptable to the Engineering Director. The contactor shall clean up debris resulting from clearing operations continuously with the progress of the work and remove promptly all salvageable material that becomes his property and is not to be reused in construction. Sale of material on the site is prohibited.

Disposal of cleared material shall be in accordance with all local and state laws. Trees cut down on the construction site will be hauled away from the site for proper disposal unless instructed otherwise by the Town. Stumps of trees cut down outside of the excavation area will be removed. Perishable material shall not be disposed of at the construction site. Brush, laps, roots, and stumps from trees shall be disposed of in a NCDEQ permitted Construction and Demolition (C&D)

Landfill[2] (i.e., land clearing and inert debris). The Contractor will be responsible for obtaining all applicable permits and paying all fees for the disposal of excess material.

3.1.6 DEWATERING

A. **Water in trenches**: When ground water in encountered, the contractor shall remove the water that accumulates in the trenches or pits, which would affect the construction of the lines or their appurtenances, by pumping, bailing, well-pointing, or other approved dewatering method and shall perform all work necessary to keep the trenches or pits entirely clear from water while bedding is being placed, the pipe is being laid, masonry units are being placed, and structures are either being set or constructed. All water removed from the trench shall be conveyed in a proper manner to a suitable point of discharge and shall comply with applicable erosion and sediment control laws. Pipe laying and pipe jointing shall be made in the "dry."

Potential groundwater control methods for temporary construction excavations include open pumping, predrainage dewatering (well pointing, and cutoff/exclusion.

Open pumping utilizes submersible sump pumps in pits or trenches dug below the bottom of the excavation and backfilled with No. 57 stone. Pumping can be performed on an intermittent basis to remove water from the construction excavations but should be continuous (24 hours a day) to maintain excavation bottom stability.

Predrainage dewatering requires the installation of temporary wells and/or wellpoints within or around the excavations, with continuous (24 hours a day) pumping both before excavation and while the excavations are in use to lower the groundwater adequately beneath the entire excavation areas.

Cutoff or exclusion involves the installation of sheet piling completely around the excavations and open pumping from inside the sheeting during excavation. Predrainage dewatering outside the sheeting can be implemented to reduce groundwater pressure on the sheetpiling and potential leakage of the sheeting at joints.

The responsibility for dewatering of construction excavations should lie solely with the contractor. This information is provided only as a guide and under no circumstance should the Town of Clayton be assumed to be responsible for the effectiveness of any of the above noted construction dewatering method(s) selected by the contractor.

B. No pipe shall be constructed in water and water shall not be allowed to drain through the pipe. The open end of the pipe shall be kept closed with a tight fitting plug to prevent washing of any foreign matter into the line.

C. No structure shall be constructed in water and water shall not be allowed to flow over or rise upon any concrete masonry structure until the work has been accepted.

[2] The construction and operation of a landfill facility for the acceptance of construction and demolition waste or debris as defined in North Carolina General Statute 130A or North Carolina Administrative Code Title 15A Subchapter 13B.

D. The contractor shall dispose of water from the trenches in such a manner to cause no injury to public health, public or private property, work completed or in progress, street surfaces, or which may cause any interference with the use of the streets. Water, if odorless and stable, may be discharged into an existing storm drain, channel, or street gutter in a manner approved by the Engineering Director. When required by the Engineering Director, a means shall be provided for desilting (filtering) the water before discharge. Under no circumstances shall water be discharged to the sanitary sewer.

E. Prevent surface water from ponding on prepared subgrades and from flooding project site and the surrounding area. Reroute surface water runoff away from or around excavated areas.

F. Do not allow water to accumulate in excavations. The cost of shoring, sheeting, gravel bedding and dewatering methods/devices shall be included in the unit price of each respective item bid. Do not use excavated trenches as temporary drainage ditches.

G. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

H. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation. Include cost of de-watering in proposal for water or sewer lines. No additional remuneration for this item is permitted.

I. Where underground streams or springs are encountered, provide temporary drainage, well pointing, or bailing. Notify the Engineering Director of such conditions.

J. Backfilling shall not take place when the trench contains water in an amount to create soupy conditions.

3.2 TRENCH EXCAVATION

3.2.1 GENERAL

A. **Excavation Safety**: All excavations should be made and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulation.

B. **Classification of Excavated Material**: All excavated material shall be classified as either earth or rock. Prices bid for the various sizes of pipe shall include excavation and backfilling; such excavation shall be classified as earth. Rock excavation shall be paid for as a separate item.

C. Remove all material of whatever nature, including but not limited to clay, silt, and gravel. Provided the material meets the requirements of paragraph 2.1.1 *Material*

Classification, subparagraph F, *Common Trench Backfill*, material of a compactible nature that can be re-used as trench backfill shall be replaced and re-compacted to the requirements set forth in these specifications.

D. **Unsuitable Material and Wasting**: When directed by the Owner's Engineer or the Engineering Director, unsuitable material in the trench shall be removed to an appropriate depth and width. At the contractor's expense, dispose of all unsuitable material, of whatever nature, to a site which legally can accept such material as fill. Adhere to all applicable laws and ordnances regarding permitting of waste site, erosion control, point zoning, etc. as may be applicable.

E. Excavation shall be performed in accordance with OSHA Standard 29 CFR Part 1926, Subpart P - "Excavations."

F. **Sanitary and Storm Sewer Alignment and Grade**: Offset stakes set at each manhole, catch basin, or curb inlet shall indicate the line and grade of the sewer. Alignment and grade of the pipe by the Contractor shall be established by laser beam or GPS equipment. The contractor shall employ personnel experienced in the use of laser beams or GPS equipment. The alignment and grade of the sewer shall be constructed as indicated on the approved plans. Prior to making changes in the field, the Engineering Director shall approve any change in grade or alignment which deviates from the approved plans. Refer to *Water and Sewer Design, paragraph 1.3.3 J* and paragraph 3.4 B, *Stormwater Design Manual* regarding acceptance for lines deviating from minimum grade.

G. Concrete collars shall be installed on lines with slopes 20% or greater.

3.2.2 PIPE COVER

A. **General**: Where lines transverse public property or are subject to other governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements as set forth by legally constituted authority having jurisdiction, but in no case less than the depth shown in the Contract Documents.

B. **Minimum Cover**: Unless shown otherwise on the construction documents, provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item. Minimum cover on pipe is measured perpendicular from top of pipe or fittings to original ground or proposed finished grade as applicable and shall be per **Table 2275.1**, below. Where the minimum cover is not provided, either use Ductile Iron Pipe or encase the pipe(s) in concrete as indicated. Provide concrete with a minimum 28-day compressive strength of 3000 psi or as permitted by the Engineering Director.

Table 2275.1

Minimum Cover *above top* of Main Pipe Lines

Utility	Condition		
	Subject to vehicular traffic	**NOT subject to vehicular traffic**	**With Concrete Encasement**
Sanitary Sewer	36[b] inches (use DIP if < 36 inches of cover)	24[b] inches (use DIP if < 36 inches of cover)	As Designed

Table 2275.1 Minimum Cover *above top* of Main Pipe Lines			
Utility	**Condition**		
	Subject to vehicular traffic	**NOT subject to vehicular traffic**	**With Concrete Encasement**
Sewer Services	At depth shown on plans but no less than 36[b] inches	At depth shown on plans but no less than 12[b] inches	As Designed
Water Distribution	36[a] inches for lines 8 inches and smaller; 42 inches for lines larger than 8 inches	36[a] inches for lines 8 inches and smaller; 42 inches for lines larger than 8 inches	18 inches (encasement, if required, shall extend to at least 5 feet beyond each side of a ditch or culvert crossing)
Water services	30[a] inches	30[a] inches	As Designed
Storm Drainage	As designed but no less than 12[c] inches for reinforced concrete pipe	As Designed	As Designed

[a]**Minimum/Maximum Cover for Water Pipe**: The Engineering Director must approve all installations of water line with less than 30 inches of cover or greater than 72 inches of cover. Lines which have less than 30 inches of cover at ditch or culvert crossings shall be Ductile Iron and encased in a steel casing. The casing shall extend through all areas until the depth of cover above the DIP is greater than 30 inches.

[b]**Minimum/Maximum Cover for Sewer Pipe**: The Engineering Director must approve all installations of sewer lines with 24 inches of cover or less or with greater than 18 feet of cover. Ductile iron pipe or C900/C905 is required where depth of pipe exceeds 12 feet or the line is placed in fill.

[c]**Minimum/Maximum Cover for Storm Drainage Pipe**: The Engineering Director must approve all installations of storm drainage lines in areas subject to traffic load with less than 12 inches of cover or with greater than 12 feet of cover. The pipe class, trench width, and/or the bedding class shall be modified for the depths exceeding 12 feet of cover to accommodate the extra depth/loads. Pipe subject to vehicular traffic shall be reinforced concrete pipe. No plain concrete pipe is permitted in traffic areas.

C. Water lines which have no more than 30 inches of cover at ditch or culvert crossings may be required by the Engineering Director to be encased in concrete. The casing shall extend through all areas until the depth of cover above the DIP is greater than 30 inches but shall extend no less than 5 feet beyond each side of the ditch or culvert.

3.2.3 TRENCHING

A. **General**: The trench for gravity pipe shall be excavated to conform to **Standard Details 511.01**, **511.02** (water and drainage), and **531.01** (sewer) as may be applicable. Where it is necessary to remove existing pavements, prepared road surfaces, sidewalks and curbs, these structures/surfaces must be replaced by the Contractor. When making a pavement cut, the Contractor shall use care to saw

cut in sharp, neat lines ahead of the excavating/ditching equipment and parallel to the pipe on each side as may be applicable. Edges of existing pavement shall be re-cut and trimmed to square, straight edges after the pipe system has been installed and prior to placement of the new base and pavement. See **Detail C01.03** for *Pavement Surface Repair for Utility Cuts* (and preparation for new asphalt patch).

All trenching shall be open-cut from the surface. No tunneling or boring will be allowed without the consent of the Engineering Director. All trenches shall be excavated to the lines and grades as shown on the plans. Where utility lines are in an existing paved area, the edges of the pavement for the utility line shall be cut in a straight line, parallel to the pipe.

Trenches shall be excavated in straight lines, in general, following the contour of the ground, and shall be accurately graded in order to establish a true elevation of the invert of the pipe. Trenches for water lines may be curved within the limits of curvature of the pipe as allowed by AWWA C600. In no case shall the trench alignment exceed the allowable vertical or horizontal pipe deflection of offset recommended by the pipe manufacturer.

1) **Trench Width**: The sides of trench shall be uniform and vertical. The width of the trench at the top of the pipe shall be a width that will permit the proper construction of joints and compaction of backfill around the pipe and shall be equal to the largest outside diameter of the pipe plus 12 inches on each side of the pipe, measured at the top of the pipe. The sides of the trenches shall be vertical unless otherwise approved by the Engineering Director. Vertical walls should project at least 2 feet above the top of the pipeline laid to existing construction grade unless the finished grade fill depth is less than 2 feet. Lowering trench wall height may necessitate a change in either pipe or bury classification. Notwithstanding, this section is subject to OSHA guidelines and regulations regarding trench protection and shoring. See **Standard Details 511.01** (Water) and **531.01** (Sewer).

   Every effort shall be made to maintain the width of the pipe plus 24 inches, but trench width must also be wide enough to provide adequate space for laying and connecting pipe and appurtenances. Sufficient space shall be allowed at the joints for the free use of wrenches for tightening of bolts.

   The minimum trench width should generally be no less than 36 inches in order to accommodate a “Rammax” trench roller.

   In excavating for the trench, it is essential that the trench bottom be uniform in grade and remains static during backfilling and under all subsequent trench conditions. To ensure a uniform depth of stone, the grade of the bottom of the trench shall be graded to within 0.04 foot (1/2-inch) of the plan specified grade. The stone shall be graded to the same tolerance.

   Care shall be taken not to over excavate the trench. All trenches excavated below grade (over excavated) shall be refilled to grade with clean #57 stone. No extra compensation shall be allowed for this work unless such excavations are ordered by the Engineering Director.

2) **Trench Depth**:

a. **General**: All trenches shall be excavated to accommodate the bedding as shown in **Standard Details 511.01, 511.02,** (water and drainage), and **531.01** (sewer) as applicable. No extra compensation will be made for stone bedding used to bring the trench up to grade other than that required in **Standard Detail C01.02** where yielding or wet subgrade is encountered.

b. **Water**: Trench depth shall generally conform to that shown on the plans and in conformity to the requirements of Table 2275.1, Minimum Cover Above Top of Main Pipe Lines.

c. **Gravity sewer**: Excavate to the depth and grades shown on the plans. Trench depth shall generally conform to the requirements of Table 2275.1, *Minimum Cover above top of Main Pipe Lines*.

d. **Storm drainage**: Excavate to the depth and grades shown on the plans. Trench depth shall generally conform to the requirements of Table 2275.1, *Minimum Cover above top of Main Pipe Lines*.

3) **Open trench exposure**: Once trench is opened, proceed immediately and with dispatch to place specified materials in trench, or to otherwise utilize trench for intended purpose. Long stretches of open trench ahead of pipe laying shall be avoided. Excavating, pipe laying, and backfilling must move forward at approximately equal rates of progress. The contractor shall only open as much ditch as he can completely install pipe, backfill, compact, and cleanup within that working day. The contractor shall string out the pipe that can be installed in one day, and no more than 300 feet of trench shall be open in advance of the completed work in any section. There shall be no trenches left open without proper supervision during working hours or after work has been completed for day. Any exception to this construction practice must be approved, in writing, by the Engineering Director. Schedule work and order materials so that trenches are not left open for a longer period than is reasonably necessary. If the contractor should fail to heed the aforementioned requirement, the Engineering Director may refuse payment until these conditions are complied with.

4) **Containment of Sediment (solids and mud)**: The contractor shall at all times so conduct his work to ensure that all solids and mud are contained within the trench. This containment shall be by the employment of a brick or block weir at the junction of new construction and the existing Town system in order to trap material for the Contractor's removal and Town's inspection prior to acceptance. The installation and removal of this dam shall be at the Contractor's expense and shall be removed before the line is televised.

B. **Design Note**: When conditions dictate (such as deep trenches, embankment installation, loading, etc.), the Engineering Director may require that the storm drainage system (or segments) be designed and constructed in accordance with the requirements of ACPA Design Data 1, *Highway Live Loads on Concrete Pipe,* and Design Data 9, *Standard Installations and Bedding Factors for the Indirect Design Method*, as applicable. Deep pipe bury in embankments may also require the designer to engage a Geotechnical Engineer and consider cambering the pipe to compensate for embankment settlement/fill consolidation.

3.2.4 SHEETING AND BRACING, TRENCH BOXES

A Certified Competent Person designated by the Contractor shall be on-site at all times excavation or pipe installation is being conducted.

Unless otherwise permitted or allowed by a Geotechnical Engineer, trench walls may have vertical sides up to a maximum depth of 5 feet above subgrade elevation. Above this depth the entire side must be laid back or either shoring or a trench box, certified for the depths being used, must be used. The contractor shall be required to furnish, put in place, and maintain such sheeting, bracing, etc. as may be required to support the sides of the trenches. Brace and sheet trenches in full observation of OSHA requirements.

Brace trenches running near walls or columns, to prevent any settlement or other disturbance of walls or columns.

Do not remove sheeting until backfilling has progressed to stage that no damage to piping, utility service, or conduit will result due to removal. All shoring and form material shall be removed before backfilling. When sheeting, bracing, or trench boxes are required, in order to prevent damage to existing facilities or structures, or as a matter of safety, or as directed by the Engineering Director, the costs are to be included in the unit prices as bid for sanitary sewers, storm drains, water lines or structures as applicable and there shall be no additional cost for these items.

Sloping trench walls: If trench walls are to be sloped or benched, contractor is responsible for determining the proper and applicable slope based on soil type in order to meet OSHA requirements. Laying back slopes also applies for areas where the top of the trench box is lower than the top of the bank. See also Section 3.2.1, paragraph A), *Excavation Safety*.

Contractor shall employ the services of a Geotechnical Engineer for direction and guidance if unstable or difficult soils are encountered. In any event, the Contractor shall hold the Town harmless for injuries and/or damages resulting from failure to properly adhere to trench protection regulations/requirements in force at the time of a failure or mishap including, but not limited to, damage to utilities, equipment, structures, paving, etc.

3.2.5 ROCK:

A. **Rock Excavation**: See paragraph 1.4 L, Rock Excavation for Trenches and Pits and paragraph 1.4 M, Rock in Open Excavations for definition of rock excavation. See also Section 02200, *Earthwork*, paragraph 1.3.H.

B. When rock is encountered in the trench, the Engineering Director must be notified before any rock has been blasted or removed. Do not perform rock excavation work until rock has been cross-sectioned, classified, and approved for removal by the Engineering Directors. The Engineering Director will measure the rock, after which, the rock shall be excavated to a depth 6 inches below the grade of pipe and the bottom of trench brought back to grade by using an approved fill material. See paragraph 3.8, *Blasting* for other requirements regarding rock excavation.

C. Intermittent drilling, blasting, or ripping performed to increase production and not necessary to permit excavation of material encountered will be deemed to be unclassified excavation

D. All over-blasted rock which has been loosened must be removed prior to backfilling.

E. The Contractor must use overburden, mats, or other means to minimize flyrock. Any damage caused by flyrock or excessive vibration will be the responsibility of the Contractor.

F. **Cushioning pipe in rock**: Special precautions shall be exercised to prevent any pipe from resting on rock or any other hard projection that might cause breakage of pipe. At no time shall the pipe bell or the pipe barrel rest on rock. A minimum of 6 inches of sand or soil (select earth) cushioning is required between the barrel of the pipe and rock. Unless directed otherwise by the Engineering Director or a Geotechnical Engineer, a minimum of 12 inches of clearance is required between the sides and bottom of the pipe and the rock. Thicker cushioning may be required for deeper pipe on a case-by-case basis. See **Standard Detail 511.03**.

G. **Disposal of Rock:** Rock excavated from the trench shall be hauled off the site at the Contractor's expense. Borrow required to replace excavated rock shall be provided by the Contractor and shall be included in the unit price bid for rock excavation. No rocks or boulders shall be used as backfill in any part of the trench. Where rock has scattered over adjoining property as a result of blasting, the Contractor shall remove the rock and restore the area to its original condition at no cost to the Town.

3.2.6 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Excavation of trenches for all pipes lines shall be done to line and grade as established by the design Engineer. The bedding surface shall provide a firm, stable, and uniform support through the entire length of the pipe. Recesses shall be excavated to accommodate bells and joints. When bedded firmly on the subgrade, the pipe shall be on the exact grade of the completed water, sewer, or storm drainage line.

In excavating for the trench, it is essential that the trench bottom be uniform in grade and remains static during backfilling and under all subsequent trench conditions. To ensure a uniform depth of stone, the grade of the bottom of the trench shall be graded to within 0.04 foot (1/2-inch) of the plan specified grade. The stone shall be graded to the same tolerance.

Excavation shall be made to grade to provide undisturbed bedding in accordance with AWWA C600.

B. **Unsuitable Trench Subgrade/Foundation Improvement**: Excavation in wet, yielding, unstable, inadequately supporting, or mucky soils shall be excavated 12 inches or more below the specified grade as shown on **Standard Detail C01.02**) using NCDOT "Type 2" Geotextile Fabric. The material shall be removed for the full width of the trench and the excavated area strengthened for foundation purposes. The over excavated material shall be replaced with thoroughly compacted Class I, II, or III materials as directed by the Engineering Director. The

trench bottom shall provide a stable and continuous support for the pipe system with bell holes provided to permit jointing.

Whenever the bottom of the trench is such that it cannot be reasonably stabilized, the Engineering Director may require the utility to be laid in a concrete mud mat, concrete encasement, cradles, in cradles supported on piles, or a combination of these materials. When necessary, the Contractor shall provide for the temporary diversion of water in order to maintain the pipe foundation in a dry condition.

Observe the following requirements when unstable trench bottom materials are encountered:

1) Notify the Town when unstable materials are encountered and define by drawing station locations and limits when encountered.

2) Remove unstable trench bottom materials as directed and replace with subgrade stabilization material specified.

B. **Over-excavation**: Unauthorized over-excavation consists of removal of material beyond indicated subgrade elevations or side dimensions, without specific approval of the Engineering Director. Exercise care to avoid excavations below established grade where firm earth conditions exist. Where unauthorized excavations have been carried beyond points required, restore these areas to the elevations and dimensions shown on the drawings with approved fill material and compact as specified (as noted in the preceding paragraph). In no case shall the pipe be brought to grade by blocking under the barrel of the pipe. A uniform support shall be provided for the entire length of the pipe. Unauthorized excavation shall be replaced at Contractor's expense.

3.2.7 TRENCH PREPARATION FOR PIPE

A. **Preparation of trenches for Gravity pipelines**

The bottom of the trench for gravity pipelines shall be excavated to a minimum over depth as shown on **Standard Detail 531.01** to provide for improved pipe bedding material for the entire length of the gravity pipeline, including sewer lateral connections, except in rock where bedding shall be a minimum of 6 inches deep (see **standard Detail 511.03** and paragraph 3.2.5 F, above). Provide **Class B** bedding for Ductile Iron sewer pipe and **Class B-1 bedding** for PVC sewer pipe (see paragraph 2.1.2, Bedding Definitions). The bedding shall be shaped so that the bottom half of the pipe rests on the bed. Bell holes and depressions as required of the joint shall be dug after the bedding has been graded and shaped, and shall be only of such length, depth, and width as required for properly making the particular type of joint. The trench for gravity sewers and lateral connections shall then be backfilled and compacted as indicated in Table 2275.3.

B. **Preparation of Trenches for Storm Drainage Pipelines**

The bottom of the trench for storm drainage pipelines shall be excavated to a minimum over depth as shown on the construction drawings in accordance with the applicable type laying condition specified (as shown on **Standard Detail 511.02**) to provide for pipe bedding for the entire length of the gravity pipeline, including lateral connections if any, except in rock where bedding shall be a minimum of 6 inches deep (see paragraph 3.2.5 F, above). Unless otherwise

directed by the Engineering Director, the bedding shall be shaped so to conform to a **Type 2** or **Type 3** (See **Detail 511.02**) laying condition with a **Class C bedding** (see paragraph 2.1.2, Bedding Definitions), as may be indicated on the drawings. Bell holes and depressions as required of the joint shall be dug after the bedding has been graded and shaped, and shall be only of such length, depth, and width as required for properly making the particular type of joint. The trench for storm drainage and lateral connections, if any, shall then be backfilled and compacted as indicated in Table 2275.3. Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with Class I, II, or III material. Rock shall be removed 6 inches below pipe and the void filled with clean stone.

C. **Preparation of trenches for Water Mains and Force** Mains

The trenches for water lines and sewage force mains shall be graded to avoid local high points. Trenches shall be graded either level or on a continuous upslope to the high points designated on the drawings. Trenches shall be of such depth as to provide a minimum cover over the top of the pipe as noted in Table 2275.1. The trenches shall have 4 inches of loose soil in the bottom before pipe is placed, so pipe is firmly and continuous in contact with the soil. Pipe shall not bridge any areas. Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with soil or clean stone. Bell holes shall be provided at each joint to permit proper joint assembly and proper pipe support. Rock shall be removed 6 inches below pipe and the void filled with coarse sand (SC, SM).

Unless directed otherwise by the Engineering Director, DIP water mains and force mains shall have a **Type 1** laying condition with Class **D bedding**. Bedding for DIP water mains shall conform to **Standard Detail 511.02**. PVC pipe bedding shall conform to **Standard Detail 531.01**. (see also paragraph 2.1.2, Bedding Definitions)

D. **Surface or Ground Water in Trenches/Pipe**

When ground water is encountered, the Contractor shall remove any water that accumulates in the trenches and shall perform all work necessary to keep the trenches clear from water while pipe is being laid. No pipe shall be laid in water and the pipe shall not be used as a means of draining ground water from the trench. All water removed from the trench shall be conveyed in a proper manner to a suitable point of discharge and shall comply with the applicable erosion and sedimentation laws. See paragraph 3.1.6 – *Dewatering*, of this specification.

The open end of water or sewer pipe shall be kept closed with a watertight plug to prevent washing of any foreign matter into the line. At the conclusion of the workday, or at any other time when pipe laying is not in progress, a watertight plug shall be placed in the bell of the last joint of pipe laid.

Storm drainage pipe shall either be plugged or an appropriate sediment trap placed at the upstream end to prevent siltation.

3.2.8 TRENCHING IN FILLS/EMBANKMENTS

In areas where trenching for pipes will be in fills or embankment fill, the fills shall be brought to an elevation of at least 12 inches above the top of the pipe, and then the trench excavated in the compacted fill, as herein specified for trench excavation.

3.2.9 SUBSURFACE DRAINAGE

Installation of subsurface drainage systems shall conform to the requirements of Section 815 – *Subsurface Drainage* of the NCDOT *Standard Specifications for Roadways and Structures*

3.2.10 EXCAVATION FOR STRUCTURES

A. Excavate to provide a minimum of 12 inches of horizontal clearance between outer surface of structure and trench wall.

B. Where rock is encountered so that a built-in-place manhole, precast structure (such as a manhole or vault), or other structure will bear over rock, remove the rock to a minimum of 8 inches below the foundation or footing of the structure and place an 8-inch cushion of clean #57 stone over the rock.

3.2.11 WATER MAIN BEND BLOCKING INSTALLATION

A. Excavate area to receive poured in place concrete blocking to exact dimensions shown in **Standard Detail 512.01**. Blocking is to be placed in undisturbed residual soils. If blocking is to be placed in areas where boulders or stumps have been removed or in areas of loosely compacted fills, such as in landscaped areas (outside of pavements or parking lots), contact the Engineering Director for directions.

B. Concrete shall be plain concrete with a minimum compressive strength of 3000 psi at 28 days.

C. Wrap fitting/bolts in minimum 6 mil polyethylene plastic prior to pouring concrete or provide other acceptable means of protection, approved by the Engineering Director before pouring concrete blocking.

3.2.12 DEPOSITION OF EXCAVATED MATERIAL

A. All excavated material shall be placed on one side of the trench away from the roadway a minimum of 2’ from the edge of excavation as required by OSHA regulations unless permission is given by the Town’s representative to place it on both sides. This offset distance from the edge of excavation may be increased when directed by either the Engineering Director or a Geotechnical Engineer considering trench depth, soils, increasing the margin of safety and/or shoring conditions.

Excavated materials shall be so placed as not to endanger the work and so that free access may be had at all times to all parts of the trench and to all fire alarm boxes, fire hydrants and gate valves on water pipes, which are located in the vicinity. Excavated material shall be placed to inconvenience the public as little as possible. All fences and walls shall be protected and, if damaged, shall be repaired or replaced in as good or better condition as before it was disturbed. Protect shade trees from stockpiling of material.

B. Exercise care when stockpiling excavated material on the bank in order to prevent surcharging the bank of the trench and potentially rendering the excavation unstable.

C. **Wasting of Unsuitable Material:** Material of an uncompactable nature, material unsatisfactory for backfill, trash and excess material shall be removed from project site and disposed at the contractor's expense. Where removal of unsatisfactory material is due to negligence on the part of the contractor (i.e. resulting from inadequate shoring or bracing, failure to dewater, improper material storage exposing it to rain or flooding, or other failure to meet specified requirements), work shall be performed at no additional cost to the Town. If additional material is required, the contractor shall supply same from an approved borrow pit at no additional cost to the Town. Rock excavated from the trench shall be hauled off the site at the Contactor's expense.

3.3 BEDDING

3.3.1 BEDDING DEFINITIONS: see paragraph 2.1.2, *Pipe Bedding Definitions*.

3.3.2 MINIMUM BEDDING REQUIREMENTS by type of pipe:

A. **Sewer Pipe Bedding**: Provide granular trench bedding material. In no case, unless specifically exempted in writing by the Engineering Director, shall the stone bedding be less than the minimum bedding shown in **Standard Detail 531.01** (Type 4[3] laying condition with for Ductile Iron pipe and laying condition Type 5[4] for PVC sewers). Unsuitable subgrade shall be improved as directed by the Engineering Director and as shown on **Standard Detail C01.02**.

B. **Bedding Water Pipe, Water Service Pipe, and Sewage Force Mains**: Unless otherwise directed by the Engineering Director, do not bed water pipe, water service pipe, and sewage force mains in stone for rock areas (see **Standard Detail 511.03**). For rock areas, bed in accordance with paragraph 3.2.5 F *Cushioning pipe in rock*.

Fine-grained Natural Soil or Backfill: Where a pipeline transitions to exposed daylight (such as aerial pipelines crossing a ravine or stream) and natural fine-grained materials or soil backfill (e.g., silts, fine-grained sand) can enter a coarse stone bedding (e.g., #57 stone) from above, and be transported through the bedding course (leaving voids above the pipe), apply one of the following measures:

1) Use well graded bedding material with minimal to no voids.

2) Place a non-woven geotextile fabric around the coarse stone bedding (lapping a minimum of 12 inches) for the entire length of pipeline where such backfill soils exist, or

[3] See American Ductile Iron Pipe Standard for clarification on the "Type" Standard Laying Condition. **Standard Detail 531.01** depicts an improved variation of American Ductile Iron Pipe Standard Laying Condition "Type 4" for DIP showing stone haunching, stone to springline of pipe, and select compacted backfill for remainder of fill to top of pipe plus 12 inches.

[4] See American Ductile Iron Pipe Standard for clarification on the "Type" Standard Laying Condition. **Standard Detail 531.01** depicts American Ductile Iron Pipe Standard Laying Condition "Type 5" for PVC pipe showing stone haunching and stone to top of pipe plus 12 inches of select compacted fill.

3) Construct clay dams at uniform intervals (40 to 50 feet on centers+/-) to arrest/prevent longitudinal water movement and transport of fine-grained soil through the coarse stone bedding material to daylight.

C. **Bedding for Structures**: The bottom of manhole bases and other precast structures and appurtenances shall be excavated to minimum over depth of 8 to 12 inches, as indicated in the applicable standard details, below the bottom of the structure. The structures shall be placed on clean stone bedding that has been firmly consolidated. Bedding material shall be shaped, graded, and compacted so that the entire bottom of the structure rests level on the material for its entire area.

3.3.3 BEDDING MATERIAL PLACEMENT

A. Unless otherwise specified, the bottom of the pipe trench for sanitary sewer, and where indicated by the Engineering Director, storm drainage pipe shall be excavated to below the bottom of the pipe, to provide for the compacted bedding materials, expect as specified in rock. Bedding material shall be placed, shaped, and compacted so that at least the bottom of the pipe rests uniformly upon the material for the entire length of the pipe. Bell holes and depressions required for the jointing of pipe shall be dug after the compacted bedding material has been graded and shaped and shall be only of the length, depth, and width required to make the joint properly. Care shall be taken to make sure bedding fills the voids beneath the pipe haunches, by poking with a shovel or tamper. See **Standard Details 511.02** and **531.01**, as applicable.

3.4 BACKFILLING (MATERIALS AND METHODS)

3.4.1 BACKFILLING

A. **GENERAL**:

1) **Materials**: See *paragraph 2.1.1 - Material Classification* for Select Earth Backfill and Common Trench Backfill classification. In areas of extensive rock excavation, where there is a shortage of suitable backfill, the contractor shall, at his own expense, haul suitable material in to be placed over and above the pipe. See the applicable standard details (**Standard Details 511.01, 531.01, 531.02**, and **533.01**) and/or the details shown on the approved drawings.

2) Pipe and fittings shall be inspected before backfilling.

3) Except as otherwise specified or directed for special conditions, backfill trenches to the ground surface with Common Trench Backfill material approved by the Engineering Director. After the pipe has been brought to grade on a proper foundation, earth fill shall be placed carefully about the pipe and tamped properly to hold the pipe in position. Exercise extreme care in backfilling operations to avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion. Repair damages, distortions, or misalignments to full satisfaction of the Engineering Director. Pipe shall be removed if broken or damaged during installation. Backfill shall closely follow the pipe installation. Unless otherwise directed or permitted by the Engineering Director, all pipe laid

shall be backfilled during the same day, and prior to the completion of the day's work, to provide a firm continuous support and covering for the pipe.

4) Reopen trenches that have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified or otherwise correct to the approval of the Engineering Director.

5) Do not allow or cause any of the work performed or installed to be covered up or enclosed by work prior to required inspections, tests, and approvals. Should any of the work be so enclosed or covered up before it has been approved, uncover all such work and, after approvals have been made, refill and compact as specified, all at no additional cost to the Town.

6) Observe specific pipe manufacturer's recommendations regarding methods of backfilling and compaction.

7) Ensure compaction of each lift to requirements stated in these specifications.

8) All pipe areas shall be graded and maintained in such a condition that erosion or saturation will not damage the pipe bed or backfill.

9) Heavy equipment shall not be operated over any pipe until it has been properly backfilled and compacted with a vibratory compaction device (i.e., Rammax trench roller or jumping jack, NO PLATE TAMP) and has a minimum cover as required by the plans. Pipe that is misaligned, shows excessive settlement, or has been otherwise damaged by the Contractor's operations, shall be removed and replaced at no cost to the Town.

10) **Installation of Warning Tape:** See paragraph 3.17.2, Identification of Water Lines for installation requirements. See paragraph 2.2.2 Warning Tape for product specifications. See the **Pre-Approved Product List** for approved manufacturers and product numbers. See also **Standard Details 511.01, 531.01, 531.02,** and **531.03** for installation requirements.

11) **Installation of RFID Marker Balls**: See paragraph 3.17.2, Identification of Water Lines for installation requirements. See paragraph 2.2.4, RFID* Marker Balls for product specifications. See the **Pre-Approved Product List** for approved manufacturers and product numbers. See also **Standard Detail C01.04** for installation requirements.

B. **METHODS**:

Provide backfill and compaction methods of following types:

1) **Carefully Compacted SELECT EARTH BACKFILL**: Furnish carefully compacted select earth backfill where indicated on drawings and specified for compacted backfill conditions up to 12 inches above top of pipe. See paragraph 2.1.1.E *Material Classification* for definition of Select Earth Backfill. Comply with the following:

Care shall be taken to prevent any disturbance to the pipe or damage to newly made joints. The filling of the trench shall be carried on

simultaneously on both sides of the pipe in such a manner that injurious side pressures do not occur such that the pipe could be displaced or dislodged. Do not backfill on muddy or frozen soil.

Sheeting and shoring generally should be removed only when the trench below it has become substantially filled, and every precaution shall be taken to prevent any slides of material from the sides of the trench onto or against the pipe.

a. Unless otherwise approved by the Engineering Director, place backfill in lifts not exceeding 6 inches (loose thickness).

b. Hand place, shovel slice, and hand tamp carefully compacted backfill solidly around pipe. Only hand tamping shall be used to compact earth around the pipeline. When the backfill has been brought to 12 inches above the top of the barrel, vibratory compaction devices (i.e. Rammax trench roller or jumping jacks, NOT PLATE TAMPS) shall be used to compact the remainder of the soil.

2) **COMMON TRENCH (FINAL) BACKFILL** Perform remaining backfill in accordance with drawings or as directed by the Engineering Director. See paragraph 2.1 *Soil, Bedding, and Backfill* for definition of Common Trench Backfill. Comply with the following:

a. Unless otherwise specified or approved by the Engineering Director, backfill the remainder of the trench, from 12 inches above the pipe to grade, with clean earth fill free of stones larger than 3 inches in diameter. Top 12 inches to be free of material greater than 1 inch. Material shall be free from all perishable and objectionable materials (organic). Before placing any backfill, all rubbish, forms, blocks, wires, or other unsuitable material shall be removed from excavation. The backfilling shall be placed in layers not over 6 inches thick in the street right of way and 12-inch layers outside of the street right of way. See Table 2275.4. Final backfill shall be tamped with a vibratory compaction device (i.e., Rammax trench roller or jumping jack, NOT A PLATE TAMP). See Table 02275.3 below, for specific density requirements.

b. All areas within the limits designated on the drawings, including adjacent transition areas, shall be uniformly graded. The contractor shall finish surfaces within the specified tolerances with uniform levels or slopes between points where elevations or existing grades are shown.

1. Finish subgrade areas that are to receive topsoil. Bring such areas to within 0.10 foot of required subgrade elevations.

2. Shape subgrade under sidewalks to line, grade, and cross-section. Subgrade is to be brought to within 0.10 foot of required subgrade elevations.

3. Shape subgrade under pavement to line, grade, and cross-section. Bring to within ½ inch of required subgrade elevations.

c. **Surface Protection – Traffic**: The contractor shall protect newly graded areas from traffic and erosion, repair, and re-establish grade in settled, eroded, or rutted areas. Where compacted areas are disturbed by subsequent construction or adverse weather, the contractor shall scarify the surface, reshape, and re-compact to the required density. If the contractor shall fail to maintain any trench within 2 days after receipt of written notice from the Engineering Director, the Town may refill said depressions and the cost of such work may be retained from monies due the contractor. In case of emergency, the Engineering Director may refill any dangerous depressions without prior notice to the Contractor.

3) **Structure Backfill**: Backfill placed within 2 feet of manholes and other special structures shall be of the same quality as that specified for backfill around water, sewer or storm drainage lines. Take care to prevent wedging action of the backfill against structure by placing the material uniformly around the structure so approximately the same elevation is maintained in each lift. Material shall be solidly tamped with a mechanical or pneumatic tamper in such a way as to avoid damaging the structures or producing unequal pressures. The Contractor shall refill all excavations as rapidly as practical after completion of the structural work therein, or after the excavations have served their purpose.

3.5 COMPACTION/DENSITY

Soil shall be compacted using equipment suitable for the material and the work area location. Power driven hand tampers shall be used for compacting materials adjacent to structures. Use hand tamper for recompaction over underground utilities.

A. **Testing**

Testing of backfill shall be performed by an independent laboratory approved by the Town and the Contractor. The Contractor shall be responsible for excavation for testing.

Quality Assurance vs. Quality Control:

Quality Assurance (QA) testing, and the associated cost, is the responsibility of the Town. Quality Assurance testing by the Town is used to confirm that the Contractor is generally performing his/her work in compliance with these specifications.

Quality Control (QC) testing is the necessary and required testing that is to be performed by the Contractor to assure that he/she is meeting and complying with the requirements of these specifications. The associated cost for QC testing is the contractor's responsibility. The contractor is also responsible for "re-testing" costs incurred by the Town when the Town's test results (tests for Quality Assurance) results in a "failure."

B. **Quality Assurance (QA):**

In the course of backfilling trenches for utility installations, the Engineering Director may require "Field Density Determinations" or compaction tests. When compaction tests are called for, the Engineering Director will determine the location

of the tests and the Town shall engage a qualified testing firm to perform the test. Field density determinations shall be performed in accordance with ASTM D698, D1556 or D2167, modified to include material sizes used in the laboratory determination of density with nuclear field density testing device or by other approved methods. A representative of the Town will observe tests and a copy of the test results and inspection report will be submitted by the testing firm directly to the Engineering Director. When the average of 3 test results, with no one test failing by more than 3 percentage points, indicate that the density is less than the percent specified, the Contractor shall excavate and re-compact the areas that have failed at no expense to the Town. Payment for failed compaction test shall be made by the contractor by deducting the cost from the forthcoming retainage or billed directly to the Contractor.

C. **Quality Control (QC):**

For Town funded projects, the Town shall pay for the cost of both Quality Control and Quality Assurance testing. However, where backfill compaction is suspect and questionable, the material shall be removed as directed by the Engineering Director and the area tested. If a suspect area fails to meet the prescribed minimum moisture density test requirements, the soil shall be removed, replaced, compacted, and re-tested, as directed by the Engineering Director, until the backfill meets or exceeds the minimum density requirements. The Contractor shall pay for all costs associated with re-testing.

Table 2275.2

Testing Frequency

Location	Frequency
Trench areas in road crossings	1 per road crossing, and/or
Trench areas	1 per 200 linear feet per two feet of fill thickness

Exception:
Where additional tests are required to determine the extent of unacceptable compaction (having been determined by the initial QA/QC test). In this case, the costs for these additional tests are the responsibility of the Contractor.

D. **Site access for testing**: Ensure that the Town, at all times, has immediate access to the site for the testing of all soils related work. Ensure excavations are in a safe condition for testing personnel.

E. **Compaction Requirements:** Unless noted otherwise on drawings or more stringently by other sections of these specifications, place and ensure backfill and fill materials achieve an equal or "higher" degree of compaction than undisturbed materials adjacent to the work; however, in no case shall degree of compaction fall below the following percentages of the maximum density at optimum moisture content. Tolerance is to be within +/- 3 percentage points of the optimum moisture content.

Table 2275.3		
Minimum Compaction Limits (Cohesive Soils)		
Location	**Density**	
Beneath and within 5 feet of buildings	100% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.	
Areas under roadway pavement surfaces, curb and gutter, and sidewalks	Top 12 inches	100% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
	Up to within 12 inches	95% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
Roadway shoulders	95% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.	
Under turf, sodded, planted, or seeded non-traffic areas	90% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.	

F. **Compaction Lifts**:

Table 2275.4	
Compaction Lift Thickness	
Compacted Lift Thickness (inches)	**Location**
6[A, B]	Inside street rights-of-way
12	Outside street rights-of-way

[A]Minimum compacted lift thickness: 6 inches. Maximum loose lift thickness: 8 to 9 inches.
[B]Allows compaction with small equipment.

G. In-place testing of soils shall be tested based on the following:

Table 02275.5	
In-Place Density Tests	
Soil Type/Classification	**Reference Standard**
Crushed Rock	ASTM D 2049 by percentage of relative density ASTM D 1557 or D 698 (standard Proctor)
GW, GP, SW and SP	ASTM D 2049 by percentage of relative density ASTM D 1557 or D 698 (standard Proctor)
GM, GC, SM, SC, ML, CL	ASTM D 2167, D1556, D2922, or D2937 by percentage of Standard Proctor Density according to ASTM D 698 or AASHTO T99

3.6 SERVICE CUTS, DIRECTIONAL BORED OR PUNCHED SERVICES

A. **Open trenches**: Sewer lateral and water service connections that cross paved streets shall be installed by saw cutting the pavement and opening the trench. The open trench width shall be no wider than 36 inches.

Lateral connection trenches in non-paved areas shall be buried as specified for gravity sewers and for water lines, as applicable. See Table 2275.1.

Do not bed water service pipe, except when rock is encountered.

B. **Directional Boring or Punching**: At the direction of the Engineering Director, service pipes may be required to be "punched" or "directional bored" beneath the pavement.

3.7 PAVEMENT REPAIR AND REPLACEMENT

A. **General**: This work shall consist of replacing subbase stone, and bituminous material in the street in areas where it becomes necessary to remove the original pavement for sewer, water main, and storm drainage trenches. Pavement repair shall be as shown on the drawings, or as determined by the Engineering Director. The pavement patch shall provide a uniform and smooth driving surface free of humps or depressions. See **Standard Detail C01.03**.

B. **Construction in Public Rights of Way**: Water, sewer, and storm drainage lines installed in or across NCDOT roads shall be installed in accordance with, if applicable, the requirements stipulated in the approved encroachment permit and the latest requirements of both the NCDOT Standard Specifications for Roads and Structures and the Roadway Standard Drawings. All water, sewer and storm drainage lines installed in or across Town streets shall be in accordance with these specifications and the applicable standard details.

When it is necessary to remove the existing pavements, prepared road surfaces, sidewalks, or curbing, it shall be the responsibility of the Contractor to replace these surfaces to original or better condition. The Contractor shall be responsible for contacting the Town or the NCDOT, as applicable. Unless specified more stringently by the owner of the right of way, the backfill shall be compacted in accordance with Table 2275.3.

Contractor shall replace pavement base with a minimum of 12 inches of ABC compacted to 100% of the Modified Proctor (ASTM D 1557) maximum dry density prior to pavement overlay.

C. When water, sewer and/or storm drainage lines are installed in or across roadways that have been macadamized or graveled, the Contractor shall save the gravel or stone, refill the upper 12 inches of the trench with the material and/or supply sufficient new stone or gravel to return the roadway to the original grade. It shall be the Contractor's responsibility to maintain the original grade by adding gravel or ABC until the ditch is stable and the pipeline accepted by the Town. Maintain area as outlined in paragraph *3.4.1 B - Surface Protection - Traffic*.

D. **Cutting Pavement**: See also **Standard Detail C01.03** and paragraph 3.1.3 B – *Protection of Surface Features*. Pavement is to be cut in straight neat lines by sawing. No chiseling, pinching, or breaking by excavators will be permitted. Perform cutting operations prior to installation of line to avoid excessive removal of asphalt.

E. **Protection of Pavement**: See paragraph 3.1.3 B – *Protection of Surface Features*.

3.8 BLASTING

3.8.1 GENERAL

A. Blasting procedures shall conform to all applicable local, state, and federal laws and ordinances and shall be performed in accordance with OSHA *Standard 29 CFR part 1910.109*, NCDOT Rules for Transporting Explosives, and local Fire Department Regulations. Prior to any blasting, a blasting permit shall be obtained. The approval of the Engineering Director shall be obtained before any blasting takes place and the Engineering Director may fix the hours of blasting if he/she deems it to be necessary. The use of explosives shall be in accordance with approved methods that safeguard lives and property. Explosives shall only be handled, placed, and detonated by persons licensed in this work. It is the responsibility of the Contractor to provide proper notification to appropriate parties.

B. **Rock Excavation**: See paragraph 1.4 L, Rock Excavation for Trenches and Pits and paragraph 1.4 M, Rock in Open Excavations for definition of rock excavation.

C. The minimum insurance coverage for blasting shall be as specified by the Engineering Director. The coverage shall include explosion and collapse. If blasting occurs within 200 feet of any underground structure or utility, underground coverage will be required. The owner and the property owners shall be named as "additional insured."

D. **Storage**: Store explosives in accordance with the Occupational Safety and Health Act, the N.C. Department of Labor Occupational Safety and Health Division's *A Guide to the Safe Storage of Explosive Materials*, and with other Federal, State and Local ordinances and regulations. A locked type 2 or 3 (as applicable) portable magazine shall be placed on site for storage of high and/or low explosives, detonators, detonating cords, ignitors and blasting agents; all in accordance with Federal and State OSHA requirements and guidelines and local permitting requirements. The These boxes shall be plainly identified as to their contents. Failure to comply with this specification shall be grounds for suspension of blasting operations until full compliance is made. No blasting shall be allowed unless a galvanometer is employed to check cap circuits.

E. The Town may prohibit blasting when the method of detonation or the means of protection provided is inadequate. Blasting conducted with or without direct supervision of the Town will not relieve the Contractor of the responsibilities stipulated herein.

F. Blasters shall not explode or attempt to explode blasting powder or high explosives unless it is performed with a suitable electric blasting machine. Electric current from batteries, telephone, or power lines shall not be used for detonation.

G. A minimum of 3 minutes prior to the detonation, the blaster shall inform competent flagmen, equipped with red flags, stationed at reasonable distances from the blast area at every avenue of approach, to warn all persons.

H. Immediately after the loading and tamping of the drill hole and before fixing the blast, the material to be blasted shall be covered on all exposed sides with blasting mats, or other approved protective material. After the protection has been applied, the blast shall be fired without unnecessary delay.

3.8.2 BLASTING PROCEDURE

A. The Contractor shall provide a blast warning signal system. The blast warning signal system shall consist of one or more air horns located at the blast site. The air horn(s) shall be audible a minimum of 1 mile from the blast site. The signals shall be one long horn 5 minutes prior to the blast, one short horn 1 minute prior to the blast, and one long horn after the blast to signal all clear. The Contractor shall erect two clear and legible blast warning signal signs at locations determined by the Engineering Director. The signs shall list the blast warning signal system, the Contractor Superintendent's name and telephone number, and the Town's representative's name and telephone number.

B. The Contractor shall establish test pits at up to two representative locations along the alignment and up to three locations adjacent to the site proposed to be blasted to determine if the rock is "rippable" with a track-mounted excavator (see paragraph 1.4 L for definition of rock excavation in open trenches and pits). If these procedures do not offer reasonable production for rock excavation, then blasting will be allowed unless otherwise indicated.

C. The Contractor shall notify in writing all property Owners within 250 feet of the proposed blast at least 1 week prior to the proposed blast and verbally on the day of the scheduled blast.

D. Blasting shall be limited to mid-morning hours on days of clear-to-partly cloudy skies with increasing surface temperature and light wind. The Contractor shall provide monitoring equipment to monitor all blasting. A copy of monitor record shall be given to the Town daily.

E. The use of unconfined explosives shall be prohibited.

F. Unless otherwise stipulated in Title 13 of the NC Administrative Code, chapter 7, the maximum allowable peak particle velocity shall be 1.25 inches per second for all structures located 0 to 300 feet from the blasting site. The maximum allowable peak particle velocity shall be 1.00 inch per second for all structures located 301 to 5,000 feet from the blasting site. The maximum allowable peak particle velocity shall be 0.75 inch per second for all structures located 5,001 feet and beyond from the blasting site.

G. To minimize vibration, minimum scaled distance (SD) of 50 shall be used to determine maximum explosive weight per delay. A test blast shall be conducted to verify the scaled distance. The maximum explosive weight per delay shall not exceed the distance from the blast to the nearest structure divided by 50 squared. Maximum explosive weight per delay may be revised pending outcome of test blast. The recommendations indicated for blasting criteria in no way relieves the Contractor of his liability.

H. The peak overpressure of air blast shall not exceed 0.015 pound per square inch or 138 decibels.

I. Preblast meetings may be scheduled with the Engineering Director to document hole depths and spacing, charge weight per delay, shot scheduling, and weather conditions. The Contractor shall obtain accurate measured distances from structures to center of blast area prior to determining the safe maximum charge-weight per delay and loading blast holes.

J. **Preblast and post blast surveys** will be performed by the Contractor. The Contractor may review this data and supplement it as he sees fit or conduct separate survey after written permission is obtained from the property Owners. In this event, the written permission shall be submitted to the Engineering Director prior to entering upon private property. The preblast and post blast surveys will include all occupied buildings within 250 feet of blasting areas. The Contractor is strongly encouraged to have a representative present during these surveys. The preblast and post blast surveys performed by the Town or the property owner in no way relieve the Contractor of his liability. See also paragraph 1.5.C.6 for other possible pre-existing conditions survey requirements and submittals.

K. The Town reserves the right to monitor production blasting. In this event, the Contractor shall provide the Engineering Director ample notice of scheduled blasts to allow set-up of monitoring equipment.

3.9 HIGHWAY CROSSING

A. Pipeline crossing shall be installed in a steel casing pipe installed by the “dry bore and jacking” method. Length of steel pipe shall be welded to the preceding length installed. The carrier pipe shall be protected by spiders constructed as shown on **Standard Detail C07.01**. The ductile iron carrier pipe shall be as specified for sewer and water pipe and shall be mechanical joint ductile iron pipe. If, in the opinion of the Contractor, boring and jacking of the highway crossing is not possible due to rock, he shall test drill, in the presence of the Engineering Director at the proposed crossing locations, at least 3 evenly spaced points in the placement along the crossing alignment. Upon verifying the presence of rock at a depth that would conflict with the boring and jacking operation, the Contractor shall make application to the Town or the NCDOT, as applicable, to allow open cutting of the crossing. The Contractor shall be responsible for providing all data and shall pay any fees required for this application. If the trench is allowed to be open cut, casing pipe shall be provided and the trench shall be backfilled entirely with flowable fill concrete to the bottom of the pavement base course and the pavement restored within one day of placing the pipe. Non-woven fabric separation fabric is to be provided between the stone and the pavement.

B. The steel casing pipe shall be of the thickness as specified in **Standard Detail C07.01**. Refer to the Pre-Approved Product List for casing pipe, spiders, and end seals specifications.

C. Installation shall be in accordance with AREA and AREMA requirements.

D. The jacking operation shall be carried on in such a manner that settlement of the ground or the highway above the pipeline will not occur. The use of water or other fluids in connection with the boring and jacking operation shall not be allowed. Excavation shall be made by auger or manual methods, at the Contractor’s option, to suit the conditions encountered. The contractor shall repair or replace, as directed by the Engineering Director, at his own expense, casing pipe damaged during the jacking operation.

E. After installation of the casing pipe, the carrier pipe, if required, shall be installed. The ends of the casing shall be plugged in accordance with **Standard Detail C07.01**.

F. All operations of the Contractor shall be subordinate to the free and unobstructed use of the highway right of way for passage of traffic without delay or danger to life, equipment, or property. The contractor shall provide all necessary bracing, bulkheads, and shields to ensure complete safety to all traffic at all times.

3.10 RAILROAD CROSSING/TRACKS

Crossing of railroad tracks with water, sewer or storm drainage lines shall be by the method shown on the contract drawings and approved by the applicable Railroad Company. It is the responsibility of the Project Engineer and Contractor to contact the Railroad Company and to comply with all Railroad Company requirements for specifications, drawings, permits, etc. All water, sewer, and storm drainage lines installed beneath railroad tracks shall be in accordance with the Railroad Company's policies, procedures, and permits requirements. The railroad right of way and track structure shall be fully restored to its original pre-existing condition and to the full satisfaction of the Railroad Company. The work shall not interrupt the use of the railroad tracks or in any way endanger the traffic on them.

3.11 RIVER OR CREEK CROSSINGS

In accordance with the contract drawings, buried river or creek crossings shall be made either by horizontal directional drilling (HDD) with HDPE pipe or constructed in the dry by providing a temporary cofferdam or bulkhead. River or creek crossings shall be in accordance with the requirements of the Engineering Director, NCDEQ, The US Army Corps of Engineers, and all other agencies having jurisdiction. Unless horizontal directional drilling is specified in the contract documents, river or creek crossings shall be made by providing a temporary cofferdam or bulkhead using ductile iron pipe for the crossing. Surface water crossings with pipe under streambed shall have the pipe encased in concrete when the cover is less than 3 feet.

River or creek crossings shall be as near to perpendicular as possible to the stream.

A. **Cofferdam Method**: The Contractor shall construct the river crossing in the "dry" by providing a temporary cofferdam or bulkhead of non-erodible material. The cofferdam shall not obstruct more than one-half of the water surface at any time and shall not extend more than 3 feet above the normal water surface. The Contractor shall not be allowed to operate construction equipment on the native steam bottom, except during removal of the cofferdam. The contractor shall be advised that the level in the river can fluctuate rapidly.

1) Non-erodible material shall be defined as heavy coarse aggregate as specified on the plans. An earth core for the cofferdam may be constructed over the proposed excavations; however, the non-erodible materials shall be in place prior to the placement of the earth, so that the erodible earth does not come in contact with the flowing water.

2) A bulkhead may be constructed in lieu of the cofferdam. The bulkhead shall be made of wood, steel or some like material suitable to withstand the hydraulic forces to permit construction in a dry trench.

3) Construct the crossings as indicated. The Contractor shall then remove the cofferdam, bulkhead, or whatever equipment or material that was used to construct the crossing. The bottom of the river in the construction area shall be restored to its original cross section. All disturbed areas on the banks of the river shall be seeded and mulched in accordance with 02920 – *Seeding and Groundcover*.

4) Comply with all terms and conditions of all permits issued by the US Army Corps of Engineers and/or NCDEQ for this work.

5) The pipe and joints of water or sewer main entering or crossing streams shall be tested in place and shall exhibit zero infiltration. This testing shall be done prior to encasing in concrete.

B. **Horizontal Directional Drilling (HDD) Method**: HDPE pipe shall be installed by horizontal directional drilling using a surface mounted rig, first to drill a guided hole along a bore path consisting of a shall arc and then to pull a string of pipe into the hole. Pull back is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe diameter. Drilling fluids are injected into the bore hole to stabilize the hole and lubricate the pipe and drilling string. Tracking equipment is used to guide and direct the drilling. See 02510, *Water Distribution* for installation, testing and other requirements for horizontal directional drilling.

3.12 SURFACE WATER CROSSINGS

Surface water crossings, with pipe above the water, shall be adequately supported by pipe support piers or beams**.**

Surface water crossings with pipe under streambed shall have the pipe encased in concrete when the cover is less than 3 feet.

See *Water & Sewer Design*, paragraph 1.2.1.P, *Stream Crossing* and **Standard Details C07.01** and **C07.02** where carrier pipe is encased.

3.13 CONCRETE COLLARS ON SEWER MAINS

Concrete collars shall be used on sewer lines with slopes 10% or greater. At least one concrete collar shall be placed before the bell of each joint of pipe. Additional collars may be required by the Town.

3.14 PLACEMENT OF RIP RAP AND RIP RAP BEDDING

Placement of Rip Rap and fabric shall conform to Section 876 – *Rip Rap* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision.

3.15 CLEANUP AND RESTORATION OF SITE

A. During the progress of the work, the Contractor shall keep the premises and the vicinity of the work clear from unsightly and disorderly piles of debris. Suitable locations shall be specified for the various construction materials and for debris. The materials shall be kept in their storage locations, except as needed for the

work and debris shall be promptly and regularly collected and deposited in the specified location.

B. Upon completion of section of pipeline and appurtenances, the Contractor shall fine grade the ground adjacent thereto, removing all surplus excavated material, leaving the area free from surface irregularities. He shall dispose of all surplus material, dirt, and rubbish from the site; and shall keep the site free of mud and dust to the satisfaction of the Engineering Director. The contractor may be required to flush or sprinkle the street to prevent dust nuisance.

C. When working on the shoulders of paved roads, the Contractor shall keep the pavement clean of all loose earth, dust, mud, gravel, etc., and shall restore road surfaces, shoulders, and ditches as required by either the NCDOT or the right-of-way owner.

D. **Grading Easements**: Easements shall be provided with a maximum 4:1 (H:V) grade parallel to sewer centerline and a maximum of 4% cross slope or less. The ground surfaces of easements shall be graded and cleared in such a way to promote proper drainage and allow mowing by vehicular equipment without damage to equipment from rocks and other debris. Also, see Water & Sewer Design, paragraph 1.3.3.Q, *Public Easements* for other easement requirements.

E. After all work is completed, the contractor shall remove all tools and other equipment, leaving the site free, clean, and in good condition.

F. The contractor shall keep the surface over and along the trenches and other excavation in a safe and satisfactory condition during the progress of the work and for a period of one year after the work has been completed. He shall be held responsible for any accidents that may occur on the account of the defective condition of such surface.

3.16 SEEDING & GROUNDCOVER

Seeding and groundcover includes seedbed preparation, liming, fertilizing, seeding, and mulching of all disturbed areas. Areas inside or outside the limits of construction that are disturbed by the Contractor's operation and activity shall be seeded and mulched.

A. Seeding, Sodding, and Groundcover shall comply with the applicable provisions and requirements of 02920, *Seeding, Sodding and Groundcover*.

B. Seeding and groundcover includes seedbed preparation, liming, fertilizing, seeding, and mulching of all disturbed areas. Areas inside or outside the limits of construction that are disturbed by the Contractor's operation and activity shall be seeded and mulched.

Unless called for otherwise on the Erosion and Sedimentation Control Plan, in areas where natural sod or vegetation has been disturbed, the area shall be seeded in accordance with **Standard Detail 350.01**.

If the line is installed through a landscaped lawn, sod shall be placed to restore ground cover to the existing lawn.

C. Seeding and groundcover includes seedbed preparation, liming, fertilizing, seeding, and mulching of all disturbed areas. Areas inside or outside the limits of

construction that are disturbed by the Contractor's operation and activity shall be seeded and mulched.

Unless called for otherwise on the Erosion and Sedimentation Control Plan, in areas where natural sod or vegetation has been disturbed, the area shall be seeded in accordance with **Standard Detail 350.01**.

D. Seeding shall be carried out as soon as practical after the construction in any one area, and shall be maintained against erosion through the completion of the project. Seeding shall be accomplished as work progresses and shall be in accordance with Sediment and Erosion Control regulations.

The Contractor shall be responsible for proper care of the seeded area during the period that vegetation is being established. In the event of an erosive rain before an adequate stand of vegetation has been established, damaged areas shall be repaired, fertilized, seeded, and mulched at the Contractor's expense.

Seeding on rights of way of NCDOT maintained roads shall be in accordance with NCDOT specifications and the requirements of the approved encroachment permit.

E. **Vegetative Practices**:

1) Contractor to refer to and follow instructions on the NCG01 Ground Stabilization and Materials Handling plan sheet and the NCG01 Inspection, Recordkeeping, and Reporting plan sheet. Contractor to follow notes on those NCG01 sheets or as shown on plans, whichever is stricter.

2) Refer to Stabilization Timeframe Table.
Per NPDES Stormwater Discharge Permit for Construction Activities, NCG01, seeding shall be placed in the timeframes shown in the table below. The timeframes shown below govern over any other less stringent note on the plans or specifications for this contract.

Stabilization Timeframes Table

Site Area Description	Stabilization	Timeframe Exceptions
Perimeter Dikes, Swales, Ditches and Slopes	7 days	None
High Quality Water (HWQ) Zones	7 days	None
Slopes Steeper than 3:1	7 days	If slopes are 10' or less in length and are not steeper than 2:1, then 14 days are allowed
Slopes 3:1 or flatter	14 days	7 days for slopes greater than 50' in length
All other areas with slopes flatter than 4:1	14 days	None, except for perimeters and HQW Zones

3) Permanently seed areas that will not be re-disturbed. Do not allow any disturbed areas to remain disturbed any longer than necessary and do not

remove protection devices until adequate ground cover has been achieved. Note that the time for establishment of permanent ground cover is 14 calendar days.

F. **Stockpile Area**: The contractor is responsible for securing a material lay down and stockpile storage area for this contract. As such, the contractor is responsible for the necessary erosion control measures, including but not necessarily limited to, a construction entrance, silt fence, protection of streams/buffers, clean up and restoration of site to the satisfaction of both the Town of Clayton and the NCDEQ, Division of Energy, Mineral, and Land Resources, Erosion and Sediment Control. Stockpile and/or waste areas must be maintained within the limits of the areas protected by the proposed measures and otherwise temporarily seeded if to be left stockpiled over 14 days.

3.17 MISCELLANEOUS

3.17.1 DUST CONTROL

A. Dust control is considered incidental and shall be carried out at the Contractor's expense.

B. **Conditions Where Practice Applies:** The contractor shall be required to control dust in the vicinity of dwellings, schools, churches, stores, or other places, where in the opinion of the Engineering Director, it is necessary to ensure that dust is held to an absolute minimum. This may also include construction roads, access points, and other disturbed areas subject to surface dust movement and dust blowing where off-site damage may occur if dust is not controlled.

C. **Design Criteria:**

1) Construction operations should be scheduled to minimize the amount of area disturbed at one time. Buffer areas of vegetation should be left where practical. Temporary or permanent stabilization measures shall be installed. No specific design criteria is given; see construction specifications below for common methods of dust control.

2) Water quality must be considered when materials are selected for dust control. Where there is a potential for the material to wash off to a stream, ingredient information must be provided to the Engineering Director or the applicable permitting authority.

D. **Construction Specifications**

1) Non-driving Areas: These areas use products and materials applied or placed on soil surfaces to prevent airborne migration of soil particles.

a. Vegetative Cover: For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control. See Section 3.16.D, above.

b. Mulch (including gravel mulch): Mulch offers a fast effective means of controlling dust. This can also include rolled erosion control blankets.

c. Spray adhesives: These are products generally composed of polymers in a liquid or solid form that are mixed with water to form an emulsion that is sprayed on the soil surface with typical hydroseeding equipment. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations for the specific soils on the site. In no case should the application of these adhesives be made on wet soils or if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators and others working with the material.

2) Driving Areas: These areas utilize water, polymer emulsions, and barriers to prevent dust movement from the traffic surface into the air.

a. Sprinkling: The site may be sprayed with water until the surface is wet. This is especially effective on haul roads and access routes.

b. Polymer Additives: These polymers are mixed with water and applied to the driving surface by a water truck with a gravity feed drip bar, spray bar or automated distributor truck. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations. Incorporation of the emulsion into the soil will be done to the appropriate depth based on expected traffic. Compaction after incorporation will be by vibratory roller to a minimum of 95%. The prepared surface shall be moist and no application of the polymer will be made if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators working with the material.

c. Barriers: Woven geotextiles can be placed on the driving surface to effectively reduce dust throw and particle migration on haul roads. Stone can also be used for construction roads for effective dust control.

d. Windbreak: A silt fence or similar barrier can control air currents at intervals equal to ten times the barrier height. Preserve existing wind barrier vegetation as much as practical.

3.17.2 IDENTIFICATION OF NEW WATER LINES

Underground Detectable Warning Tape

Underground warning tape is to be placed directly over the pipe 12 to 18 inches above the pipe for sewer pipe and 12 inches below finished grade for water mains. See **Standard Details 511.01, 531.01, 531.02,** and **531.03**.

The metallic warning tape shall be per paragraph 2.2.2, *Warning Tape* of this specification.

No separate payment will be made for warning tape as it is considered to be incidental to the cost of construction of the line being installed.

3.17.3 FLOWABLE FILL CONCRETE BACKFILL

When directed by the Engineering Director, the Contractor shall backfill trenches or undercut areas with flowable fill concrete plant mix. Except for structural applications, traffic can be placed on mixture within an hour or two after placement.

Final surfacing of pavements; however, should be delayed if possible, at least 24 hours to allow for shrinkage and hydration of concrete. Settlement of 2 to 3 inches is to be expected. See paragraph 2.1.1.C for flowable fill concrete specifications.

3.17.4 SALVAGE OF USEABLE MATERIALS

All materials such as paving blocks, brick, castings, and pipe etc., removed during excavation that is useable on this project shall only be reused after approval of its use by the Engineering Director or the applicable owner of the street right-of-way. Such material shall be stockpiled on site. Unnecessary abuse and damage to these items shall be the Contractors responsibility for replacement at Contractors expense.

End of Section 02275

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02400 - CURB & GUTTER, DRIVEWAYS & SIDEWALKS

(Last Revised 9/14/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1- General
Part 2 – Products
Part 3 - Execution
Admixtures
Concrete
Concrete Finishing
Concrete Curing
Concrete Placing Times
Concrete Strength Tests
Coordination of Pours
Curb and Gutter
Driveways
Flumes & Ditches
Forms
TrenchW
Herbicides for Bikeways
Retaining Walls
Sidewalk
Slump Test
Steel Reinforcement
Testingtesting
Welded Wire Fabric

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to the furnishing, installing, and completing all concrete work associated with concrete curbs, combination curb and gutters, ramps, sidewalks, driveways, flumes, valley gutters, median strips, islands, steps, plain and reinforced concrete retaining walls, and reinforced concrete headwalls and endwalls on municipal roadways, and appurtenances as shown on the approved construction drawings and standard details and all supplementary or miscellaneous items, appurtenances, and devices incidental to or related to placement of poured-in-place concrete, and coordination with the work of all related trades; all in accordance with provisions of these specifications and the Contract Documents.

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The following operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

1) 02200 – Earthwork

2) 02275 – Trenching, Backfilling, and Compaction of Utilities

3) 02400 – Curb & gutter, Driveways and Sidewalks

4) 02920 – Seeding, Sodding, & groundcover

5) Town of Clayton Standard Street Details

6) NCDEQ, Division of Energy, Mineral, and Land Resources, *Erosion and Sediment Control Planning and Design Manual, latest revision*

7) US Department of Labor, Occupational Safety and Health Administration (OSHA), Standard *29 CFR Part 1926, Safety and Health Regulation for Construction, Subpart P "Excavations,"* latest edition

American Society for Testing and Materials (ASTM)

1) **ASTM C33:** *Standard Specification for Concrete Aggregates*

2) **ASTM A82** Standard Specification for Steel Wire, Plain, for Concrete Reinforcement

3) **ASTM C94** Standard Specification for Ready-Mixed Concrete

4) **ASTM C136** Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

5) **ASTM C150** Standard Specification for Portland Cement

6) **ASTM C171** Standard Specification for Sheet Materials for Curing Concrete

7) **ASTM A185** Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

8) **ASTM C260** Standard Specification for Air-Entraining Admixtures for Concrete

9) **ASTM C309** Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

10) **ASTM C494** Standard Specification for Chemical Admixtures for Concrete

11) **ASTM A497** Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete

12) **ASTM A615** Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

13) **ASTM A706** Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

14) **ASTM A775** Standard Specification for Epoxy-Coated Steel Reinforcing Bars

15) **ASTM C1116** Standard Specification for Fiber-Reinforced Concrete and Shotcrete

16) **ASTM C1315** Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

17) **ASTM D422** Standard Test Method for Particle-Size Analysis of Soils (for classification purposes only)

18) **ASTM D448** Standard Classification for Sizes of Aggregate for Road and Bridge Construction

19) **ASTM D1751** Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

20) **ASTM D1752** Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

21) **ASTM D3740** Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

22) **ASTM D7382**: Standard Test Methods for Determination of Maximum Dry Unit Weight of Granular Soils Using a Vibrating Hammer

23) **ASTM D4397** Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

24) **ASTM E329** Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

25) **ASTM E548** Standard Guide for General Criteria Used for Evaluating Laboratory Competence

26) **ASTM E1745** Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

American Association of State Highway & Transportation Officials

27) **AASHTO M145** The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

28) **AASHTO M154** Standard Specification for Air-Entraining Admixtures for Concrete

29) **AASHTO M213** Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

30) **AASHTO T2** *Standard Method of Test for Sampling of Aggregates*

31) **AASHTO T99** The Moisture-Density Relations of Soils using a 5.5-pound Rammer and a 12-inch drop

32) **AASHTO T180** The Moisture Density Relations of Soils using a 10-pound Rammer and an 18-inch drop.

33) **AASHTO T191** Density of Soil In-Place by the Sand-Cone Method

34) **AASHTO T204** Density of Soil In-Place by the Drive Cylinder Method

35) **AASHTO T205** Density of Soil In-Place by the Rubber-Balloon Method

1.3 SUMMARY

A. This section includes furnishing all equipment, labor, tools, materials, and services required for complete installation of concrete curbs, combination curb and gutters, ramps, sidewalks, driveways, flumes, valley gutters, median strips, islands, steps, plain and reinforced concrete retaining walls, and reinforced concrete headwalls and endwalls on municipal roadways, and appurtenances for municipal street and greenway systems. The scope of work shall include, but is not limited to:

1) Traffic control

2) Subgrade fine grading and proof rolling

3) Base course conditioning, fine grading, and proof rolling, when applicable

4) Adjustments to utility appurtenances such as valve boxes, manhole frames, catch basin frames, etc.

5) Placement of reinforcing steel and welded wire fabric, where applicable, placement of forms and expansion joints, forms and form prep, etc.

6) Placement of concrete (poured in place or machine formed), pumping if necessary, QC testing, finishing, scoring, saw cutting pavement, curing, sealing cracks, protecting concrete, form removal, etc.

7) Related minor grading and cleanup.

8) Pavement markings when applicable

1.4 DEFINITIONS

For the purposes of this specification, the following definitions refer to the streets and roadway system that comes under the authority of the Town of Clayton, North Carolina as specified within this section and other sections of this manual.

A. **Aggregate Base Course**: A layer of graded aggregate materials of a specified thickness placed between the subgrade and the concrete structure or appurtenance.

B. **Engineering Director**: The Town's Director of Engineering or his or her authorized representative.

C. **Pervious Concrete Pavement:** Permeable pavement surfaced with cast-in-place concrete are typically referred to as pervious concrete pavement. Pervious concrete pavement is designed to allow rainfall and runoff to flow into and through the pavement structure. Permeable pavement systems consist of a surface of open-graded aggregate concrete or segmental concrete paving units with voids, joints or openings that allow water to flow freely into an open-graded aggregate

base/subbase reservoir. Permeable pavements typically require underdrains; however, when permeable pavements are placed of over high infiltration subgrade soils, underdrains may not be required (see ACI 522.1).

D. **Plans**: The approved plans, profiles, typical roadway and/or cross-sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

E. **Public Road System**: Roadway, streets, and their appurtenances required for the conveyance of the motoring public that are maintained by either the Town of Clayton or the North Carolina Department of Transportation.

F. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

G. **Subgrade**: Surface or elevation remaining after completing the excavation, or top surface of a fill or backfill immediately below pavement structure, concrete or topsoil materials, as applicable.

H. **Suitable Subgrade**: A subgrade that consists of a material type and density that is approved by the Engineering Director for placement of a subsequent concrete structure or appurtenance.

I. The following are standard abbreviations for various industries, agencies, and documents:

1) **AASHTO** American Association of State Highway Transportation Officials.

2) **ACI** American Concrete Institute

3) **ASTM** American Society for Testing and Materials

4) **C&G** Concrete Curb and Gutter

5) **D/W** Driveway

6) **FS** Federal Specifications

7) **JMF** Job Mix Formula

8) **MSDS** Material Safety Data Sheets

9) **MUTCD** Manual on Uniform Traffic Control Devices

10) **NCDEQ**: North Carolina Department of Environmental Quality

11) **NCDOT** North Carolina Department of Transportation

12) **NPDES**: National Pollutant Discharge Elimination System

13) **OSHA** Occupational Safety and Health Administration

14) **S/W** Sidewalk

15) **WWF** Welded Wire Fabric

1.5 SUBMITTALS

A. Submit product data, reports, and/or shop drawings, as applicable, for the following:

1) Air Entrainment

2) Concrete cylinder break tests

3) Concrete admixtures

4) Joint Sealants and expansion joint material

5) Job mix formula

6) Other embedded items

1.6 QUALITY ASSURANCE

A. **Geotechnical Testing Agency Qualifications**: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing as documented according to ASTM D3740 and ASTM E548. Testing Lab to be AMRL (AASHTO Materials Reference Laboratory) and CCRL (Cement and Concrete Reference Laboratory) certified.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

C. The contractor shall comply with applicable requirements of the North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, Erosion and Sediment Control plans and permit as applicable.

1.7 TESTING SERVICES

A. The Testing Laboratory shall be approved by the Engineering Director and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation.

B. Specific test and inspection requirements shall be as specified herein.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Concrete Handling/Transportation**

1) Cement concrete plant operations shall comply with the applicable sections of NCDOT *Standard Specifications for Roads and Structures*, Section 1000, *Portland Cement Concrete Production and Delivery*.

2) Time limitations and intervals between deliveries shall be in accordance with Section 1000-4.E, *Elapsed Time for Placing Concrete* of the NCDOT *Standard Specifications for Roads and Structures; Table 1000-2 Elapsed Time for Placing Concrete*.

3) See Part 3 - EXECUTION of these specifications for handling of materials during placement of hydraulic cement concrete.

B. **Steel Handling/Examination**:

1) **Steel Reinforcing Inspection**:

a. **Deformed Steel Reinforcing**: Inspect materials thoroughly upon arrival. Examine materials for damage or excessive rust. Remove damaged or rejected materials from site. A light coat of rust is permitted to develop on steel bars and fabric; however, rust scaling and flaking is not permitted.

b. **Coated Steel Reinforcing**: Handling and storage of coated bars shall conform to the requirements of ASTM A775. Visible damage to the coating shall be patched or repaired with materials compatible to the existing coating in accordance with ASTM A775.

2) **Pre-Installation Inspection**: Prior to being installed, inspect each bar of steel reinforcing for the presence of dirt, paint, oil, rust scaling, flaking or other foreign matter. Remove such matter with appropriate methods and to the satisfaction of the Engineering Director.

C. Observe manufacturer's directions for delivery and storage of materials and accessories.

D. Reinforcing steel shall be stored on platforms, skids, or other supports that will keep the steel above ground, well drained, and protected against deformation. Upon delivery to site, epoxy coated steel shall be covered with an opaque covering. Coverings shall be placed to provide air circulation and prevent condensation.

1.9 PROJECT CONDITIONS

1.8.1 PROTECTION OF STREAMS

Do not discharge excess concrete into a drainage pipe, catch basin, ditch, stream, river, pond, or lake.

1.8.2 PROTECTION OF ROADWAYS

Do not discharge or allow concrete to spill onto any roadway or appurtenances either during placement or while in transit. Remove spills immediately or otherwise repair street as directed by the Engineering Director.

1.8.3 PROTECTION FROM GRAFFITI:

Newly poured concrete roads, streets, curbs, or sidewalks shall be protected AND guarded from graffiti from passersby until the concrete has sufficiently cured to resist such molestation. Failure to prevent graffiti, or other such vandalism, shall result in the new concrete having to be removed and replaced. This requirement shall mandate the Contractor to take the necessary steps in preventing such incidents including, but not limited, to guarding the project after normal working hours.

1.8.4 WASHOUT HANDLING

A. Concrete spillage or concrete discharge to surface waters, land adjacent to any stormwater conveyance, a storm drainage pipe or stormwater inlet is prohibited.

B. Wash concrete trucks and equipment off site (in an appropriately protected area) or in designated concrete washout identified and preapproved for use. The concrete washout pit or container must be designed so that no overflows can occur due to inadequate sizing or precipitation.

C. Concrete washout pit should be lined with a leak-proof liner to avoid pit leakage.

D. Concrete washout facilities should be inspected daily and after heavy rains to check for leaks, identify any plastic linings and sidewalls have been damaged by construction activities, and determine whether they have been filled to over 75 percent capacity. check for leaks or damage to liner.

E. Once concrete wastes harden, remove, and dispose of the material.

F. The area shall be maintained and restored prior to acceptance of the project.

1.10 COORDINATION

A. Coordinate placement of sidewalk, bikeway, and driveway connections to municipal streets and roadways with the Town of Clayton Engineering Director.

PART 2 – PRODUCTS

2.1 MISCELLANEOUS

2.1.1 PORTLAND CEMENT CONCRETE

Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete.* Cement concrete shall meet the requirements of Section 1000, *Portland Cement Concrete Production and Delivery* and Section 1024, *Materials for Portland Cement Concrete* of the NCDOT Standard Specifications for Roads and Structures. Concrete strength shall be as specified on Standard Details and drawings. Unless otherwise specified, all concrete shall be Class A (3,000 psi), minimum.

All exposed concrete shall be air entrained with an air content conforming to the requirements of Section 1000-4B, *Air Entrainment* of the NCDOT *Standard*

Specifications for Roads and Structures. Air entrained admixtures for use in Portland cement concrete shall meet the requirements of AASHTO designation M-154, *Air-Entraining Admixtures for Concrete*. Only those admixtures shall be used which have been approved by the Engineering Director.

If approved by the Engineering Director, calcium chloride may be used as an admixture subject to the requirements of Section 1000-4H, *Use of Calcium Chloride* of the NCDOT *Standard Specifications for Roads and Structures*. Calcium chloride shall conform to AASHTO M144, Calcium Chloride, type 2. Do not use calcium chloride in reinforced concrete construction.

Concrete admixtures, when specified, shall conform to Section 1024-3, *Admixtures* of NCDOT *Standard Specifications for Roads and Structures*.

Concrete Classes (NCDOT) to Design Compressive Strength at 28 days (f'c):

Class	Minimum Compressive Strength at 28 days (psi)
Class AA	4,500
Class A	3,000
Class B	2,500

2.1.2 HANDRAILS

Handrails shall conform to the applicable sections and requirements of Section 460, *Concrete and Metal Rails* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision. Handrails for trail projects shall comply with the applicable subsections of Section 1074, *Miscellaneous Metals and Hardware* of the NCDOT *Standard Specifications for Roads and Structures*.

2.1.3 JOINT FILLER

A. ASPHALT EXPANSION JOINT FILLER

Joint Filler Material shall be approximately ½ inch in thickness and a width and depth equal to those of the incidental structure. However, unless otherwise directed by the Engineering Director, install expansion joint filler 1/2-inch below the concrete surface and seal with W. R. Meadows #164 Hot-Applied, Polymeric Sealant, or cold-applied "SOF-SEAL" Low-Modulus Horizontal Joint Sealant (two-component sealant) for maximum protection from water infiltration, weathering and to assure proper performance. Other non-sag sealant materials, approved by the NCDOT in Section 1028, of the NCDOT *Standard Specifications for Roads and Structures* will be permitted up approval of the Engineering Director.

Asphalt expansion joint filler material shall be in accordance with the applicable sections of Section 1028-1, *Joint Filler* of the NCDOT *Standard Specifications for Roads and Structures*. Fiber expansion joint filler shall meet AASHTO M213, *Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types);* ASTM D1751, *Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and*

Structural Construction (Nonextruding and Resilient Bituminous Types), ; Fed Spec item HH-F-341 F, Type I; FAA Spec Item P-610-2.7.

2.1.4 CURING MATERIALS

Liquid membrane curing compound, PE film, burlap, or water for curing shall meet the requirements of Section 1026, *Curing Agents for Concrete* of the NCDOT *Standard Specifications for Roads and Structures*.

2.1.5 INSULATION BLANKET

In cold weather operations, insulated blankets must retain or supply moisture and maintain the temperature at the outermost surfaces of concrete above 50º F for at least 72 hours and above 32º F for at least an additional 48 hours. For other measures pertaining to placing concrete in cold weather, see Section 420-7, *Placing Concrete in Cold Weather* of the NCDOT *Standard Specifications for Roads and Structures*.

2.1.6 POROUS BACKFILL AND WEEP HOLES

Porous backfill material and drainpipes for weep holes for retaining walls shall conform to requirements of Section 420-11, *Drains in Walls and Culverts* of the NCDOT *Standard Specifications for Roads and Structures*. Prior to backfilling, tape a 12-inch to 16-inch square piece of non-woven fabric over each hole to prevent loss of fines.

2.1.7 PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement*.

2.1.8 REINFORCEMENT

A. REINFORCING BARS

Steel reinforcing bars shall be minimum grade 60 and shall conform to the requirements of AASHTO M31, *Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing and ASTM A615 or ASTM A706.* Reinforcing bars shall also conform to the applicable requirements of Section 1070, *Reinforcing Steel*, of the NCDOT *Standard Specifications for Roads and Structures*.

B. WELDED WIRE FABRIC

Welded Wire Fabric (WWF) shall be of the size specified by the Engineering Director but shall be minimum 6 x 6 W2.9 x W2.9 sheets and shall conform to the requirements of AASHTO M32, *Standard Specification for Steel Wire, Plain, for Concrete Reinforcement,* ASTM A82 *Standard Specification for Steel Wire, Plain, for Concrete Reinforcement,* ASTM A185 *Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete,* and the applicable sections of Section 1070, *Reinforcing Steel* of NCDOT *Standard Specifications for Roads and Structures*.

WWF sheets are required and are to be properly positioned as shown on the plans and supported by chairs/sand plates. Use of rolled WWF is prohibited. WWF may not be placed on subgrade and "pulled" in to place after concrete has been poured.

2.1.9 AGGREGATE BASE MATERIAL

Aggregate base materials for foundation support shall be compacted and in compliance with Table 1005-1, *Aggregate Gradation, Coarse Aggregate* of the NCDOT *Standard Specifications for Roads and Structures*.

2.1.10 CONCRETE ADMIXTURES

Concrete admixtures, when specified by the Engineering Director, shall conform to Section 1024-3, *Admixtures* of NCDOT *Standard Specifications for Roads and Structures*.

PART 3 – EXECUTION

3.1 CONSTRUCTION – ALL CONCRETE ITEMS

3.1.1 CONSTRUCTION OF SUBGRADE

A. **SUBGRADE PREPARATIO**N: Excavation and subgrade preparation shall be in strict compliance with *02200, Earthwork*. The subgrade upon which this work is to be placed shall be shaped and compacted to a firm, even surface conforming to the elevation and cross-sections shown on the plans, the standard drawings, or as directed by the Engineer. All soft, frozen, and unsuitable material shall be removed and replaced with approved material. The subgrade shall be moist when the concrete is placed.

B. **BICYCLE/GREENWAY SUBGRADE**:

1) Pavement subgrade should be prepared in accordance with paragraph 3.1.1 A, above and shall conform to the grade and cross-section shown on the plans.

2) Herbicides shall conform to Section 1060-13, *Herbicides* of the NCDOT Specifications for Roads and Structures, latest revision shall be applied to the aggregate base course and/or subgrade immediately prior to paving. The rate of application shall be as recommended by the herbicide manufacturer. ***Herbicides shall not be left uncovered for longer than 15 minutes***. Herbicides shall not be used where they may contaminate water used for irrigation or drinking purposes.

C. **SUBGRADE FINE GRADING (Trimming)**: When forms have been set to exact grade and secured, fine grading to exact sub-grade elevation shall be completed by hand. Before pouring operations begin, the Contractor shall have forms set and grade tested and approved by the Contractor ahead of pouring operations. Subgrade fine grading shall be the responsibility of the Contractor to ensure that the subgrade conforms to the Standard Details.

3.1.2 FORMS

A. **GENERAL**: Forms for this work shall be of wood (except curb and gutter), metal, or other approved material, shall extend to the full depth of the concrete and shall be straight, free from warps and of sufficient strength to withstand the pressure of the concrete without springing. Bracing and staking of the forms shall be such that the forms will remain in both horizontal and vertical alignment until their removal. Forms shall be cleaned of foreign matter and oiled before concrete is placed. No concrete shall be poured into forms which have not been checked and approved.

3.1.3 PLACING – ALL CONCRETE ITEMS

A. **Placing Steel Reinforcement** (Bars or Fabric): Place steel reinforcing bars and fabric at the position shown on the plans and as required by the following (as applicable):

1) Detail and fabricate reinforcing steel in accordance with ACI 315r, *Guide to Presenting Reinforcing Steel Design Details*, latest revision.

2) WWF sheets are to be used to enable steel fabric to be set at the depth shown on the plans. WWF rolls may not be used. Fabric sheets may not be placed on the subgrade and "pulled" into place (after concrete has been poured and screeded).

3) Rebar Clearances: Unless otherwise noted on the plans, rebar shall have the following minimum clearances from the face of the cast-in-place concrete.

a. Permanently exposed to earth (e.g., footings, retaining walls):
   1. 3" when cast against earth (i.e., earth forms)
   2. 2" with removable forms (1 ½" clear if No. 5 or smaller)

b. Exposed to earth of weather (formed concrete slabs, walls, and beams)
   1. 1 ½" for No. 5 and smaller
   2. 2" for No. 6 through No. 18

4) Laps:

a. Lap all WWF splices two full meshes, one full mesh on all sides, and tie-off with standard wire ties.

b. See plans/plan notes for required reinforcing bar laps.

5) Stagger the centerline of adjacent laps of continuous reinforcing 5'-0" o/c or the splice length plus 1-foot; whichever is greater.

6) Placement of reinforcing steel shall be in place and inspected prior to placing concrete.

B. **Placing Concrete**: The concrete shall be placed in the forms in such a manner as to prevent the segregation of the mortar and the aggregate. The concrete shall be spaded, tamped, or vibrated sufficiently to bring the mortar to the surface. Concrete shall not be dropped a distance of more than 5 feet.

Prior to and during pouring operations, the Contractor's foreman or formsetter shall carefully watch all alignment and grades to detect any errors in grade or

misalignment. In the event any of the work is damaged from any cause or prove defective in any way, or is out of alignment or grade, the Contractor shall remove such work and replace at his own expense. The detection of poor subgrade shall also be his responsibility.

When sufficient concrete has been placed in the forms, it shall be well spaded along all areas in contact with the forms in order to eliminate all honeycombing. Mix shall be rodded or vibrated to eliminate voids. Concrete shall be floated to the proper grade and alignment, free from depressions or other irregularities, after which the exposed surfaces shall then be screeded with a straight edge and finished with a steel or wooden trowel. The concrete shall be troweled smooth and, before the concrete obtains full set, very lightly brushed with a brush moistened with clear water. No mortar shall be used in the finishing. Immediately following finishing operations, the finished concrete shall be cured and protected in accordance with these specifications.

3.1.4 COORDINATION OF POURS

It will be the responsibility of the Contractor to coordinate the times of pours with the Inspector. Sufficient notice shall be given to the Inspector so that he/she can check all aspects of the work before the pouring operations begin. Under no circumstances shall the Contractor pour concrete until the Inspector has had sufficient time to make checks of the work. An inspection shall be requested at least 24 hours prior to any pouring operation.

The maximum interval between the placing of batches at the work site shall not exceed 20 minutes. See Section 1000-4E, *Elapsed Time for Placing Concrete* and

NCDOT Table 1000-2 (excerpted)
ELAPSED TIME FOR PLACING CONCRETE

	Maximum Elapsed Time	
Air or Concrete Temperature (Whichever is higher)	**No Retarding Admixture Used**	**Retarding Admixture Used**
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below[A]	60 minutes	1 hr. 45 minutes
70°F through 79°F[B]	60 minutes	1 hr. 45 minutes
69°F or below[B]	1 hr. 30 minutes	2 hr. 15 minutes

[A]Applicable to Class AA, A, and drilled pier concrete
[B]Applicable to Class B concrete

Table 1000-2 of the NCDOT *Standard Specifications for Roads and Structures. Place concrete before exceeding the time in Table 1000-2, below. Measure the elapsed time as the time between adding the mixing water to the mix and placing concrete.*

3.1.5 FINISHING

Concrete for curb, curb and gutter, sidewalks and driveways shall have a broomed finish. This finish shall be accomplished as follows: the surface shall be screeded and tamped to force the coarse aggregate away from the surface, floated to bring

the surface to the required finish level, steel-troweled to an even smooth surface and broomed with a fiber-bristle brush. The surface shall be uniform in texture.

3.1.6 CURING

A. **CURING – YEAR AROUND**

Curing shall be accomplished by preventing loss of moisture, rapid temperature change, and mechanical injury from rain or flowing water for a period of 7 days when normal Portland cement has been used or 3 days when high early strength Portland cement has been used. Curing shall be started as soon as placing, finishing, and free water has disappeared from the surface of the concrete. The following methods of curing are required year-round:

1) **Liquid membrane compound**: Apply membrane–curing compound for curing, sealing, and moisture retention. The entire exposed surface of the structure shall be sprayed uniformly with a white pigmented membrane-forming compound immediately following the texturing operation. The curing compound shall be applied in 2 coats by hand.

   Perform application in accordance with manufacturer's directions but at a minimum rate of 100 to 150 square feet per gallon and not more than 350 square feet per gallon (total for both coats). Application shall be by a sprayer or long-nap roller and shall be an even, continuous membrane produced on the concrete surface. The second coat shall be applied in a direction approximately at right angles to the direction of the first coat. No puddling shall be produced. At the time of use, the compound shall be in a thoroughly mixed condition, with pigment uniformly dispersed through the vehicle. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections.

   The membrane shall harden 30 minutes after application. Personnel and equipment shall be kept off the freshly applied material to prevent damage to the seal. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected for 7 days from pedestrian and vehicular traffic and from any other action which might disrupt the continuity of the membrane. If the membrane becomes damaged within the initial 72 hours, damaged portions shall be repaired immediately with additional compound.

   If removal of forms is required, exposed sections shall be protected immediately to provide a curing treatment equal to that provided for the surface.

2) **Polyethylene Film**: Concrete shall be covered with polyethylene film (PE). Color of film shall be white. However, from November 1 to April 1, either clear or opaque PE film will be permitted. Film shall be installed immediately after liquid membrane compound has obtained a sufficient set so that it is not damaged. Apply film so that marks from application are not produced.

B. **COLD WEATHER CURING**

No concrete is to be poured when the outside ambient temperature is 40º F and falling. Cold weather curing shall be applied when the outside temperature is 50º F and falling. When the temperature falls to or below 35º F, no concrete work of

any kind is to be performed. Permission given by the Engineering Director to place concrete when the temperature is below 35°F, and the subsequent protection of the concrete as required herein, does not relieve the Contractor in any way of the responsibility for obtaining the required results.

1) Concrete Temperature: Conform to the requirements of paragraph 420-7, Placing Concrete in Cold Weather of the NCDOT Standard Specifications for Roads and Structures, for the required temperatures of concrete.

2) Cold subgrade: No concrete is to be placed on a frozen subgrade.

3) In addition to year-round curing, install insulated blankets that will retain or supply moisture and maintain the temperature of concrete at the outermost surfaces above 50º F for at least 72 hours and above 32ºF for at least an additional 48 hours. Blankets shall be left in place for a minimum of 7 days.

4) In cold weather applications, calcium chloride may be used as an admixture, if approved by the Engineering Director, provided the concrete is not reinforced.

C. **HOT WEATHER CURING**

Hot weather curing shall be applied when the outside temperature is 75°F and rising. Care shall be taken in hot, dry, or windy weather to protect the concrete from shrinkage cracking by applying at a minimum liquid membrane compound and Polyethylene film as described in paragraph 3.1.6 A, above.
Routine hot weather measures shall include cooling forms and wetting subgrade in addition to any of the other measures.

Other measures for curing may be required by the Engineering Director, such as: fog spraying, sprinkling, ponding, windbreaks, shading, or wet covering with an approved light-colored material. Such curing may be required to remain in place for a minimum of 7 days. No extra compensation will be made for curing of concrete.

D. **DAMAGED CONCRETE**

Any work damaged due to improper curing, freezing, or rain, shall be replaced at the Contractor's expense.

3.1.7 PROTECTION OF CONCRETE

A. Protect new concrete sidewalks and appurtenances from pedestrian traffic for a minimum of 24 hours and do not open to pedestrian traffic for the first 5 days. Vehicular traffic shall be excluded for the first 14 days or until the minimum design compressive strength is attained, whichever is the lesser time.

Protect new concrete driveway surfaces and curb and gutter from vehicular traffic for minimum of 7 days or until the minimum design compressive strength is attained, whichever is the lesser time, unless otherwise approved by the Engineering Director. Erect and maintain warning signs, lights, and watchmen to protect pedestrian and to direct traffic as needed.

B. Protect concrete against public traffic, construction equipment and traffic caused by employees and agents. Repair or replace parts of concrete damaged from such prior to final acceptance.

C. No equipment shall be driven or moved across newly concreted surfaces unless such equipment is rubber-tired and only if paved surface is designed for and capable of sustaining loads to be imposed by the equipment.

D. Protect concrete from graffiti (see paragraph 1.8.3 *Protection From Graffiti*).

3.1.8 TESTING

A. **Testing:**

On a case-by-case basis, at the discretion of the Engineering Director, the Contractor may be required to perform concrete testing in accordance with the following provisions.

Table 3.1.4
Minimum Sampling for Concrete
(Field Test Procedures and Standards)

Test	By Load	By Volume	Other
Slump (AASHTO T119) / ASTM C143	First load and, every 5th load	A random load per 30 cy	When test cylinders made
Temperature - pressure air meter (ASTM C1064)	First load, every 5th load	-	When test cylinders made
Compression Test Specimens (AASHTO T23 / ASTM C31)	Each placement operation	Each 100 CY	-

1) **Initial Test**: The initial test (from first ready mix truck) is to be taken after the second yard is dispatched from the mixer and is to consist of the following:

   a. One slump test
   b. Temperature
   c. Pull, prepare and store three 6x12 cylinders on-site for 24 hours. Do not store at locations subject to vibration. Deliver to lab for a 7-day, 14-day, and 28-day compressive strength testing (Break Testing).

2) **Second Test**: After the above tests are pulled from the initial truck, every 5th truck thereafter is to be tested in the same manner as noted above.

3) **Subsequent Test**: Slump tests may be required at any time during the pour if for any reason the Town Representative or Contractor feels the conditions of the concrete have changed. If the slump test fails, test cylinders of that section shall be taken by the Contractor.

4) **Compressive Strength Testing**:

a. Prepare at least 3 test cylinders for each concrete sample tested.
   1) Break 1 test cylinder at 7 days
   2) Break 1 test cylinder at 14 days.
   3) Break 1 test cylinder at 28 days.

5) **Evaluating Break Tests**: If the average compressive strength of 3 consecutive specimens falls below the minimum strength specified above, or if the compressive strength of any single specimen falls more than 500 psi below the minimum compressive strengths specified above in **paragraph 2.1.1** or the minimum compressive strength shown or specified on the plans; the Engineering Director may require the following:

   a. Change in mix design for the remaining portion of the work.

   b. Additional curing of the affected concrete followed by cores taken in accordance with the latest editions of ASTM C42 and ACI 318, all at the expense of the Contractor.

   c. If additional curing does not bring three average compressive strength of three cores taken in the affected area to at least the minimum strength specified, the Engineering Director may require that the Contractor strengthen the structure by means of additional concrete and steel or he may require that the Contractor to replace the affected portions.

   d. The cost of all such changes in mix designs and any modifications to or replacement of deficient concrete shall be borne by the Contractor at no additional cost to the Town of Clayton.

6) **Reporting**: In addition to providing testing reports to the Contractor, the Testing Lab/Concrete Field Testing Technician is to email/forward/provide a copy of all test results on the same day as the test was conducted to the following:

   a. The Town's Project Inspector

   b. The Project Engineer

7) **Allowable Slump**: See NCDOT *Standard Specifications For Roads and Structures* Table 1000-1 *Requirements for Concrete*.

Table 3.1.5 Slump Test Limitations

APPLICATION	ALLOWABLE SLUMP	REFERENCE
Hand poured Curb and Gutter (Class A, 3000 psi concrete)	4" max (Non-Vibrated)	NCDOT Table 1000-1
Machine formed Curb and Gutter (Class AA Slip Form, 4500 psi concrete)	0-1 1/2" max (Vibrated)	NCDOT Table 1000-1
Other Applications	As specified by Engineering Director or per NCDOT[a] Table 1000-1, as applicable	

[a] NCDOT *Standard Specifications For Roads and Structures*

8) **Sourcing Concrete from Two or More Concrete Producers:**

a. **Mixing Concrete from Two or more Batch Plants/Producers**: On large area or massive concrete volume projects, utilizing the same performance strength, the use of multiple suppliers is possible or sometimes unavoidable. On these projects where concrete is sourced from two or more suppliers or batch plants, the inspector shall take his samples from a single truck, note the truck ID, batch time, source, and record the exact placement location of the concrete sampled/placed/poured. Each supplier/batch source shall adhere to the aforenoted sampling requirements/frequencies.

b. **Do not mix sources of concrete** (such as alternating suppliers' trucks and pouring into one area or pump). For record keeping purposes, segregate batch sources. If two or more suppliers are utilized, the Project inspector shall ensure that there is a clear dividing point (e.g., a construction joint) and take samples for testing from both suppliers. Clearly annotate dividing line or joint on redlined record drawings.

9) **Testing Costs**: The cost of Quality Control (QC) tests, tests to assure the Contractor that he/she is meeting and complying with the requirements of these specifications, is the Contractor's responsibility. The cost of Quality Assurance (QA) tests, tests performed independently by the Town of Clayton to confirm that the Contractor is generally performing his/her work in compliance with these specifications, is the responsibility of the Town of Clayton.

3.1.9 DEFECTIVE WORK

The Town will require the removal and replacement of any concrete items where they have structural cracks, have been broken, chipped, have become misaligned, grades are incorrect, does not meet dimensions as shown in the Standard Details, improperly cured, or of a substandard or non-approved product. Such areas designated by the Engineering Director shall be repaired at no cost to the Town. Items replaced shall conform to the requirements for new work as to strength and construction. During removal of defective work, an amount equal to the required lengths of construction joints must be removed and replaced.

The Engineer may drill cores from completed slabs of concrete to make depth measurements. Sections showing a deficiency of more than 3/8 inch shall be removed and replaced to the specified depth at the Contractor's expense.

3.1.10 CONCRETE CLASS

Concrete class for combined curb and gutter, curbs, sidewalks, driveways, flumes, ditches, steps, headwalls, and islands shall be a minimum Class A, (3,000 psi) concrete or as designated in the specifications or on the drawings. However, machined formed curb shall be Class AA (4,500 psi) concrete.

3.2 STANDARD CONCRETE CURB AND GUTTER

3.2.1 GENERAL REQUIREMENTS

This work shall consist of a single course of Portland cement concrete, constructed on a prepared subgrade in accordance with these specifications. It shall have the dimensions, cross-section, and location as shown on the plans or as directed by the Engineering Director. See **Standard Detail 402.01** for standard vertical curb & gutter, median curb & gutter and, and mountable roll type curb & gutter.

Horizontal alignment of curbs and combined curb and gutter shall be in reasonably close conformity to the lines shown on the plans. Vertical alignment shall not exceed +/- 3/8 inch in 10 feet from plan grade.

Before concrete obtains full set, all exposed surfaces shall be finished with a brush moistened with clear water.

When constructing curb and gutter, the Contractor will be responsible for filling and compacting material in the space left behind the curb and gutter after the forms are removed. This shall take place within 3 to 7 days from pour and the material shall be compacted to the grade of the back of the curb. No extra compensation shall be made for this work.

Dowels shall be placed in the throat plate, to tie gutter to plate as required in the use of conventional forms.

A. **JOINTS FOR CURB AND GUTTER:**

1) Transverse joints:

a. Transverse joints for crack control for fixed forms shall be provided at the following locations:

1. At approximately 10-foot intervals;

2. At the gutter where the curb and gutter ties to the gutter apron of drop inlets;

3. When time elapsing between consecutive concrete placements exceeds 45 minutes, and

4. Where no section shall be less than 6 feet in length.

b. Transverse joints for crack control may be formed by using one of the following methods:

1. Removable 1/8-inch-thick templates.

2. Scoring or sawing for a depth of not less than 3/4 inch when using curb machine.

3. Approved “leave-in” type insert or may be formed or created using other approved methods which will successfully induce and control the location and shape of the transverse cracks.

4. Place joint sealant in cracks after removal of templates.

If templates are used for transverse joints, templates shall be removed by stages, but not entirely until the concrete has become thoroughly hard. After removal of the templates, there must be a clear division throughout between these sections. Edging tools will be used to form an edge along the back and front form and at each template.

2) Expansion joints:

a. See Part 2 – PRODUCTS paragraph 2.1.3, *Joint Filler* of these specifications for approved expansion materials.

Curb and Gutter expansion joints shall be formed at intervals of approximately 90 feet on centers, at all radii points at concrete entrances and curb returns, at locations no less than 3 feet and no more than 10 feet from drop inlets, at the end of days' work, and or all cold joints.

3.2.2 FORMS – CURB & GUTTER

A. FIXED FORMS

Steel forms shall be used for the construction of curb and gutter. Fixed forms shall be straight, free from warp, and of such construction that there will be no interference with the inspection of grade and alignment. Metal templates, not more than 3/16 inch in thickness and manufactured in accordance with the curb and gutter section, shall be set in the places provided in the forms not more than 10 feet apart. Templates shall be adjusted to prevent short sections (less than 5 feet). Forms shall extend the entire depth of the item and shall be braced and secured so that no deflection from alignment or grade will occur during concrete placement. Radial forms shall be sufficiently flexible or otherwise designed to provide a smooth, uniform, curved surface of the required radius. When sufficient concrete has been placed in the forms, it shall be well spaded along all areas in contact with the forms in order to eliminate all honeycombing. Face forms shall be removed as soon as concrete has attained sufficient set for the curb to stand without slumping. The exposed surface shall then be smoothed by the use of a suitable finishing tool.

B. SLIP FORMS

In some places the Contractor may desire to use the slip form method to pour curb and gutter. In such cases approval from the Engineering Director will be required. The Contractor's proposed equipment must receive the approval of the Engineering Director.

1) **Equipment**: The slipform equipment shall be self-propelled and shall be equipped to consolidate, form, extrude, and finish the freshly placed concrete in such a manner that a minimum of hand finishing is required to produce a dense, consolidated, homogenous product. Slipform equipment shall be controlled to line and grade by automatic sensing, guidance, and control devices such that the machine automatically senses and follows taut guidelines or other stable reference, performing any necessary corrective action to ensure the correct grade and alignment is achieved.

The Contractor shall plan and stage the work to eliminate the need for the slipform machine to be stopped during placement operations.

2) **Attachments**: The forms on the equipment must meet the precise dimensions shown on **Standard Detail 402.01** for the different types of curb. A sufficient number of vibrators shall be provided on the machine and be in good working order.

3) **Line and Grade Controls**: It shall be the Contractor's responsibility to set the line and grade controls for his machine. These controls shall be checked by the Town's Contractor before any "trimming" or pouring occurs. However, approval of these controls by the Town's Contractor shall not relieve the Contractor of the responsibility of obtaining the planned grade or alignment according to the construction stakes.

4) **Subgrade Trimming**: It shall be the responsibility of the Contractor to ensure that the subgrade conforms to the Standard Details and approved plans. No extra payment shall be made to the Contractor for "trimming" the subgrade if such "trimming" is less than 6 inches. Before pouring operations begin, the subgrade shall be checked by the Town's Contractor.

5) **Pouring Operations**: Before the machine starts a pour, the slump of 4,500 psi (Class AA) slip formed concrete will be checked in the presence of the Town's Contractor. This slump for vibrated machine place concrete must be 1.5 inches[1]. In the event that the slump exceeds 1.5 inches, the concrete will be rejected.

   If it is determined by the Town's Contractor that the poured curb or gutter does not meet the exact dimensions of the "standard drawings" or for some other reason it does not conform to these specifications, (alignment, grade, materials, etc.) then the Contractor, at his own expense, shall remove the faulty work before concrete obtains full set. No compensation shall be made for unsatisfactory work.

   The Contractor shall make sure that sufficient vibration of the concrete occurs. If vibrators fail to function, all operations shall cease until they are satisfactorily repaired.

   Where storm inlets are designated, the Contractor shall either leave a sufficient blank space to be hand formed later or work concrete to the exact dimensions for the standard inlet specified.

3.3 STANDARD PORTLAND CEMENT CONCRETE SIDEWALK AND DRIVEWAY ENTRANCES

3.3.1 GENERAL REQUIREMENTS

This work shall consist of the construction of Portland cement concrete or asphalt sidewalk 4 inches thick and in accordance with these specifications and to the

[1] Ref: NCDOT Table 1000-2, Concrete Requirements

widths shown in the applicable Standard Details. Sidewalks crossing driveway entrances shall be constructed 6 inches thick. See **Standard Detail 404.03** for sidewalk and **Standard Details 404.01** and **404.02** for driveway entrance openings. The width of driveways shall be 10 feet minimum to 24 feet maximum for residential driveways. Commercial driveway width shall be as approved by the Engineering Director.

Unless otherwise shown on the plans and approved by the Engineering Director, all sidewalks shall maintain a ¼ inch per foot (2%) transverse slope.

Curb cuts for driveways and handicap ramps shall be constructed as shown on the Town's Standard Details for the type driveway or ramp specified on the plans or as directed by the Engineering Director.

Handicap ramps shall be constructed at all street intersection corners and at other major points of pedestrian crossing. The ramps shall be constructed as shown on the Town's standard drawings for the type shown on the plans or as directed by the Engineering Director to meet Americans with Disabilities Act/Architectural Barriers Act (ADA/ABA) requirements.

Domes are required on all accessible ramps. Contact Town Inspector for proper color for domes and size on accessible ramps. See **Standard Detail 405.15**.

Wire mesh or reinforcing steel will be used if recommended by the Engineering Director or shown on plans. For installation of mesh or steel, see Section 425, *Fabricating and Placing Reinforcement* of the NCDOT *Standard Specifications for Roads and Structures.*

The foundation shall be thoroughly moistened immediately prior to concrete placement. Concrete shall be placed in forms by methods that will prevent segregation. Concrete shall be spread to the full depth and brought to grade by screeding and straightedging. Concrete shall be spaded adjacent to forms to prevent a honeycomb appearance, and the surface shall be floated with a wooden float to produce a surface free from irregularities. The final finish shall be obtained with an approved hand float that will produce a uniform surface texture. Light brooming may be used to hide trowel marks. Outside edges of the sidewalk slab and joints shall be edged with an edging tool having a radius of 1/4 inch.

When required as part of construction, reinforcing steel shall be properly spaced and thoroughly tied before concrete is placed.

All sidewalks (new or existing) fronting a new development shall be free of cracks, breaks, or other defects prior to receiving a Certificate of Occupancy.

See also paragraph 3.1.7, *Protection of Concrete*.

Tolerances: Horizontal alignment of sidewalks shall be to the lines and grades as shown on the plans and details. Vertical alignment shall not exceed +/- 3/8 inch in 10 feet from the plan grade.

A. JOINTS FOR CONCRETE SIDEWALK AND DRIVEWAY ENTRANCES

Transverse expansion joints shall be constructed at intervals of approximately 40 feet (see **Standard Detail 404.03**). Slabs shall be separated by transverse preformed joint filler ½-inch in thickness that extends from the bottom of the slab to approximately ¼-inch below the top surface.

The slab between expansion joints shall be divided into sections equal in width to the sidewalk by transverse score joints formed by a jointing tool, trowel, or other approved means. Transverse control joints shall also be provided when the time period between consecutive concrete placements is more than 45 minutes. Control joints shall extend into concrete for at least 1/4 of the depth (e.g., 1 inch for 4-inch concrete sidewalk) and shall be approximately 1/8-inch in width. Where slabs are more than 7 feet in width, the Engineering Director may require that scored control joints shall be formed longitudinally to obtain secure uniform blocks that are approximately square. Transverse control joints shall also be installed where the corners of the drop inlets project into the sidewalk.

Expansion joints shall be formed around appurtenances extending into and through the sidewalk. An expansion joint shall be formed and filled with ½-inch preformed joint filler no less than 3 feet and no more than 10 feet from drop inlets. Preformed joint filler shall also be installed between concrete sidewalk and any adjacent fixed structure which is not tied to the sidewalk with steel dowels.

B. **PLACING CONCRETE**

See paragraph 3.1.3, *Placing*, above.

C. **FINISHING**
See paragraph 3.1.5, *Finishing*, above.

D. **CURING**

See *paragraph 3.1.6 Curing* for requirements for curing concrete.

E. **FORMS**

1) **Fixed forms**: See paragraph 3.2.2 A *Fixed Forms*, above.

2) **Slip forms**: Slip form pouring shall be allowed with approval of the Engineering Director. All portions of paragraph 3.2.2 B, *Slip Forms*, above, concerning pouring operations with slip forms shall apply.

3.4 PORTLAND CEMENT CONCRETE RETAINING WALLS, HEADWALLS, STEPS, PIERS FOR STREAM CROSSINGS, FLUMES AND DITCHES, MEDIAN BARRIERS, MEDIAN STRIPS, ISLANDS, ETC.

3.4.1 GENERAL REQUIREMENTS

This work shall consist of Portland cement concrete retaining walls, headwalls, steps, piers for stream crossings, flumes and ditches, median barriers, median strips, islands, etc. constructed in accordance with these specifications. These structures shall be constructed to the dimensions, cross-section, and located as shown on the plans, shown on the Standard Details, or as directed by the Engineering Director.

A. **REINFORCING STEEL**

Reinforcement steel shall be placed in accordance with the drawings, the Concrete Reinforcing Steel Institute's (CRSI) *Placing Reinforcing Bars*, 10th Edition or latest, the latest edition of ACI 318, *Building Code Requirements for Reinforced Concrete,* latest edition and Section 425, *Fabricating and Placing Reinforcement* of the NCDOT *Standard Specifications for Roads and structures*. See also paragraph 2.1.8, *Reinforcement* of this specification.

B. **HANDRAILS**

Handrails shall be placed in accordance with Section 1074, *Miscellaneous Metals and Hardware* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

C. **FLUMES AND DITCHES**

Concrete flumes and ditches shall be constructed in accordance with Section 850, *Concrete Paved Ditch* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

D. **MEDIAN BARRIERS, MEDIAN STRIPS AND ISLANDS**

Concrete median barriers, median strips, and islands shall be constructed in accordance with Section 852, *Traffic Islands and Medians* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

E. **PIERS FOR STREAM CROSSINGS, STEPS, HEADWALLS AND RETAINING WALLS**

Concrete retaining walls shall be constructed in accordance with Sections 420, *Concrete Structures* of the NCDOT *Standard Specifications for Roads and Structures*.

END OF SECTION 02400

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02510 - WATER DISTRIBUTION

(Last revised 9/27/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1- General
Part 2 – Products
Part 3 - Execution
Air Release Valve-Spec
Backflow Preventers
Butterfly Valve - Spec
Check Valve - Spec
Ductile Iron Pipe - Spec
DIP - Installation
DIP Fittings
DIP Joints
Fire Hydrant Painting
HDPE Pipe
HDPE – Directional Bore
Hydrant Bagging
Fire Hydrant-Spec
Fire Hydrants-Setting
Gate Valves-Spec
1 ½" & 2" Service-Spec
Meter Boxes, Small-Spec
Meters, who furnishes
Meters
Parallel Pipe-Clearances
Pipe Crossing Clearances
Pipe Bury
Pipe Separation Reg'ts
Pressure Test & Leakage
PVC Pipe Spec
Residential/Commerial W/S Services
Steel Encas't Pipe-Install
Steel Encasement Pipe-Spec
Sterilization
Small Service Connections-Spec
Tunneling Method
Tunnel Liner - Spec
Tapping Sleeve & Valve-Spec
Vault Access Frames-Spec
Valve Boxes-Spec
Warning Tape

PART 1 – GENERAL

1.1 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including the General Requirements and Supplementary Conditions apply to this specification.

B. The following materials and operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM standard specification references without a year designation implies the most current applicable specification.

1) The pipe and fittings shall be designed, manufactured, and installed in accordance with industry standards and shall comply with the specification requirements herein.

2) 02275 – Trenching, Backfilling, and Compaction of Utilities.

3) **ASTM A48**: *Standard Specification for Gray Iron Castings*

4) **ASTM A53**: *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

5) **ASTM A126**: *Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings*

6) **ASTM A139**: Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

7) **ASTM A536**: *Stand Specification for Ductile-Iron Castings*

8) **ASTM B43**: *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*

9) **ASTM B88**: *Standard Specification for Seamless Copper Water Tube*

10) **ASTM C478**: *Standard Specification for Circular Precast Reinforced Concrete Manhole Sections*

11) **ASTM C3350**: *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

12) **ASTM F593:** *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

13) **AASHTO M199**: *Standard Specification for Precast Reinforced Concrete Manhole Sections*

14) **AASHTO M306**: *Standard Specification for Drainage, Sewer, Utility, and Related Castings*

15) **AWWA C104/A21.4**: *Cement-Mortar Lining for Ductile-Iron Pipe and Fittings*

16) **AWWA C105/A21.5**: *Polyethylene Encasement for Ductile Iron Pipe*

17) **AWWA C110-21**: *Ductile-Iron and Gray-Iron Fittings*

18) **AWWA C111/A21.11***: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*

19) **AWWA C115-20**: *Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron*

20) **AWWA C150-21**: *Thickness Design of Ductile Iron Pipe*

21) **AWWA C151/A21.51**: *Ductile-Iron Pipe, Centrifugally Cast*

22) **AWWA C153-19**: *Ductile-Iron Compact Fittings*

23) **AWWA C219**: *Bolted Sleeve-Type couplings for Plain-End Pipe*

24) **AWWA C502**: *Dry-Barrel Fire Hydrants*

25) **AWWA C504**: *Rubber-Seated Butterfly Valves*

26) **AWWA C508**: *Swing-Check Valves for Waterworks Service, 2" though 48" NPS*

27) **AWWA C509**: *Resilient-Seated Gate Valves for Water Supply Service*

28) **AWWA C510**: *Double Check Valve Backflow Prevention Assembly*

29) **AWWA C511**: *Reduced-Pressure Principle Backflow Prevention Assembly*

30) **AWWA C512**: *Air Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service*

31) **AWWA C515**: *Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service*

32) **AWWA C550**: *Protective Interior Coatings for Valves and Hydrants*

33) **AWWA C600**: *Installation of Ductile-Iron Mains and Their Appurtenances*

34) ***AWWA C701****: Cold-Water Meters-Turbine Type, For Customer Service*

35) ***AWWA C702***: *Cold Water Meters-Compound Type*

36) **AWWA C710**: *Cold-Water Meters-Displacement Type, Plastic Main Case*

37) **AWWA C800**: Underground Service Line Valves and Fittings

38) **AWWA C901**: *Polyethylene (PE) Pressure Pipe and Tubing, ¾" through 3" for Water Service*

39) **AWWA C906**: *Polyethylene (PE) Pressure Pipe and Fittings, 4" through 65" for Waterworks*

40) **NSF/ANSI 61, NSF/ANSI 372** (Reduction of Lead in Drinking Water Act), latest revision: *Drinking Water System Components – Health Effects*. (Note: NSF 372 is NOT a standard. It is a method of measurement used to comply with the standard; therefore, anything that has a full NSF 61 Certification has been certified to NSF 61 via the methods and values defined in NSF 372).

1.2 REFERENCED STANDARDS ORGANIZATIONS

A. **AASHTO** American Association of State Highway Transportation Officials.

B. **ANSI** American National Standards Institute

C. **AREA** American Railway Engineers Association

D. **ASSE** American Society of Sanitary Engineers

E. **ASTM** American Society for Testing and Materials

F. **AWWA** American Water Works Association

G. **FM** Factory Mutual System

H. **FS** Federal Specifications

I. **MSDS** Material Safety Data Sheets

J. **NCDEQ** North Carolina Department of Environmental Quality

K. **NCDOT** North Carolina Department of Transportation

L. **NFPA** National Fire Protection Association

M. **NSF** National Sanitation Federation International

N. **OSHA** Occupational Safety and Health Administration

O. **UL** Underwriters Laboratories, Inc.

1.3 SUMMARY

This section includes all equipment, labor, material, and services required for complete installation of water distribution piping and specialties for municipal water and fire-service mains and services.

1.4 DEFINITIONS

For the purposes of this specification, the following definitions refer to water distribution systems that come under the authority of Town as specified within this and other sections of this manual.

A. **Competent Person**: Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

B. **Engineering Director:** The Town's Director of Engineering or his or her authorized representative.

C. **Fire Service**: Exterior firefighting/suppression water piping.

D. **Fire Marshall**: The Town of Clayton's appointed Deputy Chief/Fire Marshall responsible for Fire Code enforcement and investigating fires for origin and cause.

E. **Plans**: The approved plans, profiles, typical roadway or trench sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

F. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

G. **Water Main**: Exterior water systems for both domestic water and fire suppression needs.

H. **Water Service**: Exterior water piping used to provide water for domestic purposes.

The following are industry abbreviation for various pipe materials:

A. **AC**: Asbestos Cement Pipe
B. **CI**: Cast Iron Pipe
C. **DIP**: Ductile Iron Pipe
D. **HDPE**: High Density Polyethylene Pipe
E. **PVC**: Polyvinyl Chloride Pipe
F. **RCP**: Reinforced Concrete Pipe

1.5 SUBMITTALS

A. Submit product data for the following:

1) Pipe and Fittings
2) Valves and accessories.
3) Water meters and accessories.
4) Detector Check Valves
5) Backflow preventers and assemblies.
6) Fire Hydrants.
7) Fire Department Connections.
8) Castings
9) All appurtenances proposed for use on a project that may not be listed here.

B. Submit shop drawings:

1) For precast concrete vaults including frames and covers, drains, access hatches, wall sleeves, valve support stands, prefabricated above ground vaults, and backflow prevention devices.

2) Upon request, valve manufacturers shall furnish certified copies of test reports.

3) For any product submitted as an *"or approved equal"* that is not specifically specified in this specification.

1.6 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of all applicable Codes and Standards.

B. Piping materials shall be marked clearly and legibly.

1) Ductile Iron Pipe shall show identification marks on or near bell as follows:
   a. Material Designation,
   b. Rating Designation,
   c. Weight,
   d. Class or nominal thickness,
   e. The letters "DI" or "Ductile" cast or stamped on pipe
   f. Manufacturer's identifying mark,
   g. Year in which pipe was produced,

h. Casting period.

2) Steel pipe shall be marked as follows. Each length of pipe and each special section shall be legibly marked by paint stenciling, die stamping, or hot-roll marking to show the following:
   a. Manufacturer's name or mark,
   b. Size and weight of the pipe or special section,
   c. The type of steel from which the pipe or special section was made.

3) PVC Pipe shall show proper marking of pipe as required in the applicable product specification and shall remain legible during normal handling, storage, and installation. The manufacture date of the pipe must be within 1 year of the proposed date of installation. Marking of PVC pipe commonly includes:
   a. Manufacturer's Name,
   b. Nominal Pipe Size and Size Base,
   c. PVC Cell Classification or Material Code,
   d. Dimension Ratio or Standard Dimension Ratio,
   e. Product Type, Pressure Class or Pressure Rating,
   f. Standard Specification Designation,
   g. Production Record Code.
   h. A laboratory mark or seal if the pipe is to be used for potable water.

C. Comply with Factory Mutual's *"Approval Guide*" and Underwriters Laboratories, Inc. "*Fire Protection Equipment Directory*" for fire-service main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, and flushing and valve and hydrant supervision for fire mains.

E. Comply with NSF/ANSI 61 and NSF/ANSI 372 for materials for water service piping and specialties for domestic water.

F. Comply with all applicable AWWA and ANSI standards.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

Materials used for the construction of water mains and appurtenances in the Town's water distribution system shall be new, free of defects, and meet the highest standards set forth. An authorized Town representative must inspect, review, and approve all materials to be used for water lines and appurtenances prior to installation. At the option of the Town, any material installed without inspection will have to be sufficiently removed for inspection and review. Any additions, deletions, or changes from the Town approved plan set must be submitted to Engineering Director for approval, prior to making changes in the field.

A. **Pipe Conditions/Pipe Examination**:

1) **New pipe inspection upon arrival**: Inspect each truckload of materials thoroughly upon arrival at the site. Examine material for damage and to ensure that the right pipe has been delivered to the site. Pipe shall be protected during handling against impact shocks and free fall. Care shall be taken when unloading pipe to avoid damaging the pipe lining. Pipe that has been damaged either in transit or during unloading shall be plainly marked and shall not be used in the construction of the utility. Pipe shall

be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM specifications.

2) **Prior to laying pipe**: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with theses specifications. All pipe in which spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. All pipe damaged or deemed not to conform to these specifications, shall be plainly marked and shall not be used in the construction of the utility. The faces of all spigot ends and all shoulders on the bells must be true, without lumps or rough edges, and be brought in fair contact. Examine bell and spigot for uniformity and smoothness of liner and barrel.

B. Inspect fittings and structures thoroughly upon arrival for damage. Remove damaged or rejected materials from site.

C. Observe manufacturer's directions for handling, delivery, and storage of materials and accessories.

D. Protect pipe coating during handling using methods recommended by the manufacturer. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

E. Protect stored piping from entry of water or dirt into pipe. Store pipe on shoulders and not in ditch lines. String out no more pipe than can be installed in a day. Also, protect bells and flanges of special fittings from entry of moisture and dirt. If pipe is provided with end protectors, do not remove protectors until ready for installation or for inspection. Once inspected, replace protectors.

F. Support pipe to prevent sagging or bending.

G. Use slings to handle valves and fire hydrants if size requires handling by crane or other type of lift. Do not use handwheels or stems to lift or for rigging points.

H. Store fire hydrants and valves in such a way as to prevent entry of water and dirt into openings. Support on skids or pallets off the ground or pavement. If fire hydrants or valves are provided with end protectors, do not remove protectors until ready for installation or for inspection. Once inspected, replace protectors. Protect valves against damage to threaded ends or flanges.

1.8 PRODUCT SUBSTITUTIONS

Refer to the Town’s Pre-Approved Product List (PAPL) for a list of approved manufactures and their products permitted on the Town’s Water system. The Engineering Director, may at his/her discretion, approve materials not specified but deemed equal, on a case-by-case basis. Submit documentation and samples of materials. New materials approved for the water distribution system may be incorporated into these specifications after approval.

1.9 PROJECT CONDITIONS

1.9.1 Separation of water and sanitary and/or combined sewers.

A. Follow the NCDEQ standards for separation of water mains and sanitary sewers lines (*Title 15A, Subchapter 18C .0906 of the NCAC*). Also, see **Standard Detail C01.05** for a graphic representation of the *Minimum Separation of Utilities and Other Features*; most noted below.

B. **Parallel Installations**:

1) **Preferred/Normal Condition** – Water lines shall be constructed at least 10 feet horizontally from a sewer or sewer manhole whenever possible. The distance shall be measured edge-to-edge.

2) **Unusual Conditions** – When local conditions prevent a horizontal separation of at least 10 feet, the water line may be laid closer to a sewer provided that:

a. The water main shall be placed in a separate trench, with elevation of the bottom of the water line at least 18 inches above the top of the sewer; or

b. The water main shall be placed in the same trench as the sewer, and located to one side, on a bench of undisturbed earth, and the elevation of the bottom of the water main shall be at least 18 inches above the top of the sewer; or

c. If it is impossible to obtain proper horizontal and vertical separation as described above or anytime the sewer is above the water main, both the water main and sewer must be constructed of DIP complying with public water supply design standards and must be pressure tested to 150-psi to assure watertightness before backfilling. The sewer manhole shall be of watertight construction and tested in place.

C. **Water Mains Crossing <u>Above</u> Sewers**:

1) **Preferred/Normal Condition** – Water lines shall be constructed to cross over sewers whenever possible and shall be laid to provide a vertical separation of at least 18 inches between the bottom elevation of the water line and the top of the sewer.

2) **Unusual Conditions** – When local conditions prevent an 18-inch vertical separation as described in *Crossing,* Preferred/*Normal Conditions* (paragraph above), one of the following construction methods shall be used:

a. Both the water main and sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling.

or

b. Either the water main or the sewer main may be encased in a watertight encasement pipe which extends 10 feet on both sides of the crossing, measured perpendicular to the water main. The encasement pipe shall be of materials approved by NCDEQ for use in water main construction

(e.g. DIP, steel). If the sewer main is encased, the DIP sewer carrier pipe shall be DIP continuous from manhole to manhole. If the water main carrier pipe is encased, the water shall be constructed of either DIP or PVC meeting these specifications.

D. **Water Mains Crossing Below Sewers**:

1) **Unusual Conditions** – When local conditions prevent an 18-inch vertical separation, as described in paragraph C, *Water Mains Crossing Above Sewers, Preferred/Normal Conditions*, above, the following construction shall apply:

a. Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling.

b. Provide adequate structural support for the sewers to prevent excessive deflection of the joints, which can result in settling on and/or the breaking the water line.

E. **Water Mains and Other Utilities**

1) **Horizontal Separation: Preferred/Normal Condition** – Water lines shall be constructed to provide at least 3 feet of horizontal separation from other utilities whenever possible. The distance shall be measured edge-to-edge. For Asbestos Cement lines, provide a minimum of 5 feet of clear horizontal separation.

2) **Vertical Separation: Preferred/Normal Condition**: Whenever it is necessary for another utility to cross a water main, a 12-inch vertical separation shall be maintained between the lines. When local conditions prevent a 12-inch vertical separation, the following construction shall apply:

a. Provide adequate structural support for the utility to prevent excessive deflection of the joints, which can result in settling on and/or breaking the water line. See **Detail C01.05**, sheet 4 of 6.

F. **Sanitary Sewer Manholes** – No water mains shall pass through or come in contact with any part of a sewer manhole. A minimum of 3 feet of horizontal separation shall be maintained between water mains and sanitary or combined sewer manholes provided that the applicable provisions of paragraph B, *Parallel Installations, Unusual Conditions*, above, are also met.

G. **Sanitary Sewer And Water Services**: Unless stated otherwise below, the separation requirements for water and sewer services fall under the requirements the *NC State Building Code: Plumbing Code (IPC with North Carolina Amendments),* section 603.2 *Separation of Water Service and Building Sewer*, latest revision. Those provisions are generally as follows:

a. A minimum 12-inch vertical separation, with bottom of water service above the top of the sewer, and pipe material meets the provisions of Section 603.2 *Separation of Water Service and Building Sewer*.

   Water service pipe and the building sewer shall be separated by 5 feet of undisturbed or compacted earth. The required horizontal separation distance of 5 feet shall not apply where the bottom of the water service pipe, located within 5 feet of the sewer, is not less than 12 inches above the highest point of the top of the building sewer. However, in accordance with *Water & Sewer Design*, paragraph 1.2.1.R, *Water Distribution*, the horizontal separation between a water and sewer service within a public right of way or utility easement shall be no less than 3 feet. See **Standard Detail C07.03**).

b. Water can be located in same trench with sewer if pipe material meets the provisions of paragraph 603.2 and Table 702.2.

c. The required separation is not required where a water service pipe crosses a sewer pipe provided the water service is sleeved to a point 5 feet horizontally on either side of the sewer pipe centerline with pipe material meeting Table 605.3, Table 702.2 or Table 702.3 of the NC State Building Code: Plumbing Code, latest revision.

H. **New Utilities and Existing Water Mains** – When installing a new utility adjacent to or in close proximity to an *existing* water main, the new utility line shall be installed to provide the minimum horizontal and vertical clearances specified in paragraph 1.9 E, *Water Mains and other Utilities*.

1.10 CROSS-CONNECTION CONTROL

Refer to the Town of Clayton *Cross-Connection/Backflow Protection Ordinance* (Chapter 53), latest adoption as applicable. See paragraph 2.2.2 for Backflow Preventers device specifications.

1.11 SERVICE INTERRUPTION

Contact the Town of Clayton Engineering Department to coordinate interruption of service, operation of valves, line cut-ins, or placement of a tapping sleeve and valve. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of Engineering Director, temporary service may be required to be provided. Provide a minimum of 72 hours' notice of the proposed utility interruption or necessary operation of valves.

1.12 COORDINATION

A. Coordinate tie-in to municipal water mains with the Engineering Department. Except as needed for fire suppression purposes, the Town of Clayton will be the sole operator of all valves and hydrants on the Town's water distribution system. Adequate notifications to water customers will be given by the Town of Clayton prior to any interruption of service. Service is to be continuously maintained to customers in the project areas except for the minimum amount of time required to make connections with the existing system. Only in the case of an emergency may a valve be closed by a Contractor. Records shall be kept of any valves closed

during an emergency and the Engineering Director shall be notified of the specific valves closed at the earliest reasonable time following such valve closure.

Before shutting off any main, residents are to be notified by the Town of Clayton's representative in writing at least 72hours in advance of cut off. The Contractor shall provide assistance to the Town in notification distribution. The Town shall be notified at least 1 week in advance of request for operation of valves and making either a wet tap or cut-in.

B. Contact ***"NC One Call"*** at 811 before digging.



C. When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 48 hours' notice prior to anticipated disturbance or interruption. At the discretion of the Engineering Director, the notice may be required to be published in the newspaper.

D. Repair of pavement markings: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing. Repairs shall be made using either liquid Thermoplastic Traffic Marking Paint or Preformed Thermoplastic pavement marking materials.

E. Water Service Shut-off

The Contractor shall notify the Town of Clayton at least 72 hours prior to need for water shutoff. Additionally, the Town of Clayton requires adherence to the following procedures prior to shutting off water service on any existing Town line:

1) The Contractor must receive approval for shut-off from the Engineering Director. Generally, shut-offs must occur from 9:00 AM to 11:00 AM and 2:00 PM to 4:00 PM on weekdays.

2) After receiving approval, the Town of Clayton shall notify affected residents in writing 48 hours in advance of beginning operation.

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 COPPER TUBE SERVICE PIPE

Copper pipe shall meet ASTM B88 *Standard Specification for Seamless Copper Water Tube*, Type K, water tube annealed temper soft drawn for use with compression type (brass) fittings for ¾-inch through 2-inch below ground services. Copper tubing shall be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

2.1.2 DUCTILE IRON PIPE

Ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA C151/ ANSI A21.51 *Ductile-Iron Pipe, Centrifugally Cast, for Water* for 4-inch and larger diameter pipe, pressure class rated, 350 minimum (rated working pressure plus 100 psi allowance for surge) (See Design Section) for 4-inch and larger diameter pipe, pressure class rated, and shall be in 18 or 20-foot lengths. The thickness of Ductile Iron Pipe shall be determined by considering trench load and internal pressure *(the pressure zone and variances in which the pipe will be used)* separately in accordance with AWWA C150/ANSI A21.50 *American National Standard for Thickness Design of Ductile-Iron Pipe*.

The ductile iron pipe shall be cement mortar lined with a seal coat in accordance with AWWA C104/ANSI 21.4 *Standard for Cement–Mortar Lining for Ductile-Iron Pipe and Fittings*. Outside coat shall be a minimum of 1-mil bituminous paint according to AWWA C151/ANSI A21.51 Section 51-8.1. Pipe shall be stamped as required by AWWA C151.

Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacturer to 500-psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

All materials used in production of the pipe are to be tested in accordance with AWWA C151 for their adequacy within the design of the pipe, and certified test results are to be provided to Town upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, Griffin Pipe Products Company, or United States Pipe and Foundry Company.

Pipe shall be furnished complete with accessories per AWWA C111/ANSI A21.11 *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*.

Ductile Iron Pipe to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

A. **Ductile Iron Joints**

Pipe joints may be either mechanical joint or push-on pipe sizes 4 inches through 48 inches. Acceptable types of pipe joints are as follows:

1) **Push-on Joint, Ductile Iron Pipe** shall conform to AWWA C151/ANSI A21.51 *Ductile-Iron Pipe, Centrifugally Cast, for Water* (such as "Fastite" or “Tyton,") The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWA C111/ANSI A21.11 *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*.

2) **Mechanical Joint, Ductile Iron Pipe** shall be used only at the specific locations indicated on the drawings or as approved by Engineering Director.

a. The mechanical joint shall consist of:

i. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;

ii. A pipe or fitting spigot;

iii. Mechanical Joint Gaskets to be plain rubber (Styrene Butadiene [SBR]) per AWWA C111/ANSI A21.11;

iv. Separate ductile iron follower gland having cored or drilled bolt holes; and

v. Alloy steel Tee Head bolts and hexagon nuts. All threads are Coarse-Thread Series Class 2A, External and Class 2B, Internal, per ANSI B1.1. Nuts to be furnished in accordance with ASTM A563, *Standard Specification for Carbon and Alloy Steel Nuts*.

b. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements of Federal Specification WW-P-421, AWWA C111/ANSI A21.11, and ASTM A53 Standard Specification of Ductile Iron Castings.

c. Mechanical Joint Bolt Torque:

See section 3.1.1 below, paragraph B, item b, *Installing Mechanical Joint Pipe*.

d. Mechanical joint pipe shall be UL Listed and FM Approved.

3) **Mechanical Joint Restraint**: Acceptable types of joint restraints shall be:

a. Restrained Joints shall consist of the use of a mechanical joint restraint system. Bolt heads are to be “auto-torque” twist off. See Paragraph 2.1.2, B, 3), below for approved manufacturers and models.

b. Restrained Joint Pipe shall be TR Flex as manufactured by United States Pipe and Foundry Company or McWane, Inc., Flex-Ring or Lok-Ring as manufactured by American Cast Iron Pipe Company, Snap-lok as manufactured by Griffin Pipe Products Company.

4) **Flanged Joints** shall be firmly bolted with machine bolts; however, where valves or special fittings are attached to a flange pipe, stud or tap bolts may be used, providing the number used and diameter for each joint is the same for each respective size of pipe or special, or valve, as recommended by the latest AWWA Standard for flanged drilling. Bolts are specified in ANSI B18.2.1 and nuts are specified in ANSI B18.2.2. Bolts and nuts are to be cold worked 304 stainless steel meeting ASTM F593 *Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs* for sizes up to 1.5 inches. Stainless steel bolts and nuts shall have a minimum yield strength of 50,000 psi. For high strength applications, use 304L stainless steel bolts. Bolts shall be of sufficient length to pass through two flanges and the nut threads shall be accurately cut,

close fitting, and the prevailing standard. Bolt heads shall be cut square and nuts hexagon in shape, both the heads and nuts being chamfered. Gaskets to be of 1/8-inch-thick plain rubber (Styrene Butadiene [SBR]) per AWWA C111/ANSI A21.11 or equal as approved by Engineering Director.

Threaded flanged pipe shall conform to the requirements of ANSI/AWWA C115/A21.15.

The underground use of flanged joints is not permitted

B. **Ductile Iron Fittings**

Fittings shall be ductile iron, ASTM A536, grade 70-50-05 (70 ksi Tensile Strength minimum), and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings, pipe sizes 4 inches through 48 inches with the exception of manufacturer's proprietary design dimensions and thicknesses for iron, in accordance with AWWA C110/ANSI A21.10. All ductile iron fittings shall have a minimum working pressure rating of 350 psi (Class 350) (3" through 24") and 250 psi (30" through 48") and shall be cement mortar lined and bituminous coated (minimum 1-millimeter), in accordance with AWWA C104/ANSI A 21.4. The fittings shall be tested and the manufacturer shall provide certified test results when requested by Town. This testing shall include hydrostatic proof testing of fittings. Glands, gaskets, and bolts shall conform to AWWA C111/ANSI A 21.11. The use of push on Ductile Iron fittings is not permitted. See the **Pre-Approved Product List** (PAPL) for approved Manufacturers.

Ductile Iron Fittings to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

1) **Full Body Mechanical Joint Fittings:** Full body ductile iron mechanical joint fittings shall be minimum class to be 250 and shall conform to AWWA C110/ANSI A21.10. Glands, Gaskets and Bolts shall conform to AWWA C111/ANSI A21.11.

2) **Mechanical Joint Fittings – Compact:** Compact fittings shall be minimum class 350 and shall comply with AWWA C 153/ANSI A21.53, pipe sizes 4 inches through 48 inches. Glands, Gaskets and Bolts shall conform to AWWA C111/ANSI A21.11.

3) **Mechanical Joint Restraint (Restrainer) Systems** (3-inch through 48-inch)**:** Mechanical joint restraint systems shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Mechanical joint restraint systems (gland body, wedges and wedge actuating components) shall be constructed of ASTM A536, grade 65-45-12 ductile iron and shall conform to the requirements of either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.51. For applications requiring restraint 30 inches and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable provided the device meets all the end product performance requirements. An identification number consisting of the year, day, plant and shift, shall be cast into each gland body. Sizes 3-inch through 16-inch shall be rated at 350-psi minimum working pressure and sizes 18 inches and larger rated at 250-psi minimum working pressure. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes. Bolt heads are to be "auto-torque" twist off. Mechanical joint restraint systems shall accommodate all classes of

ductile iron pipe (pressure class 350 through pressure class 150 and class 56 through 50) and appurtenances such as valves and hydrants without damage to the fitting, pipe or cement linings. Consult with manufacturer when use is intended for grey iron pipe. All components shall be manufactured and assembled in the United States. See **Standard Detail 512.02**, sheet 2 for figure.

Hardware (T-Bolts and nuts) to be grade 316 stainless steel; furnished by Restraint Gland manufacturer.

See the Pre-Approved Product List (PAPL) for approved Manufacturers and models.

2.1.3 PVC PIPE – C900 (6" THROUGH 12" MAINS)

PVC pressure pipe, 6-inch through 12-inch, with bell end with gasket and spigot end shall comply with AWWA C900, Pressure Class 150, DR 18, ASTM D3139, ASTM F477, ASTM D1784, NSF 61, and shall bear the seal of the National Sanitation Foundation for potable water pipe. Pipe OD shall be equivalent to ductile iron pipe of the same nominal size. Pipe joints shall include elastomeric gaskets and shall be integral bell type coupling. Lubricant and gaskets are to be supplied with the pipe by the manufacturer of the pipe. C900 pipe shall be used with ductile iron fittings (restrained joint).

Fusible C900 pipe, used for directional boring, shall only be used with written approval from the Engineering Director.

2.1.4 POLYETHYLENE WATER PIPE

A. HDPE water pressure pipe, tubing, and fittings shall be manufactured in accordance conform all applicable provisions and requirements of the latest revision of AWWA C901, AWWA C906, or CSA B137.1, DR9, 200-psi, ASTM D2239, ASTM D2737, ASTM D3035, ASTM F714 and, by inclusion, all appropriate standard references therein. Polyethylene compounds utilized in the manufacture of products furnished under this specification shall be as defined in ASTM D3350, Cell Class 445574C/E. PE Pipe shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1250 psi (PE2406/2606) or 1600 psi (PE3408/PE3608) at a temperature of 73.4°F (23°C).

All materials which come in contact with water, including lubricants, shall be evaluated, tested, and certified for conformance with ANSI/NSF Standards 14/61.

Clean re-work material of the same type grade, and cell classification generated from the manufacturer's own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing, and fittings produced meet the requirements of AWWA C901, AWWA C906, or CSA B137.1.

All HDPE pipe shall be one size larger than connected pipe (i.e., 8-inch PVC to 10 inch HDPE)

B. **Reference standards**

AWWA C901: Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service.

AWWA C906: Polyethylene (PE) Pressure Pipe and Tubing, 4-inch through 63-inch for Water Service.

ASTM D2657: Standard Practice for Heat Joining Polyolefin Pipe and Fittings.

ASTM D2683: Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis of Thermoplastic Pipe Materials.

ASTM D3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

ASTM F714: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

ASTM F1055: Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

PPI TR-3: Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

PPI TR-4: Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fitting Compounds.

ANSI/NSF: Standard Number 61 for Drinking Water Systems Components – Health Effects.

NSF Standard #14: Plastic Piping Components and Related Materials.

CSA B137.1: Polyethylene Pipe, Tubing, and Fittings for Cold Water Pressure Services.

C. **Qualification of Manufactures**

The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. Given reasonable notice, the manufacturer's production facilities shall be open for inspection by Town or their representative. See the Pre-Approved Product List (PAPL) for list of approved Manufacturers.

D. **Manufacturer's Quality Control**

The manufacturer of the Polyethylene pipe and fittings shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall

be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in AWWA C901 or AWWA C906, as applicable.

E. **Pipe and Tubing**

Pipe and tubing furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above. Dimensional performance characteristics shall conform to the requirements of AWWA C901, C906, or CSA B137.1. The pipe's DR (Dimension Ratio) and Working Pressure (WPR) shall be as specified or shown on the drawings.

F. **Fittings**

Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above and all appropriate requirements of AWWA C901, C906, or CSA B137.1 Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings produced from material not listed in paragraph A above, shall be approved only after submission of appropriate test data and service histories indicating their acceptability for the intended service. In all cases, the specifications and requirements of the fittings supplied shall comply with the appropriate section of AWWA C901, C906, or CSA B137.1.

G. **Pressure Class**

The Pressure Class of the Polyethylene pipe and fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to one half of the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's nominal pressure class may be ignored due to the fatigue endurance of the polyethylene materials. Non-polyethylene fittings shall be specified and used in accordance with the surge tolerance of the particular appurtenance in use.

H. **Marking**

Pipe and tubing shall be marked in accordance with either of AWWA C901, AWWA C906, or CSA B137.1, whichever applies. Marking shall be legible and shall remain legible under normal handling and installation practices. Indent marking may be utilized provided; 1) the marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing, 2) it has been demonstrated that these marks have no effect on the long term strength of the pipe or tubing and, 3) the marks do not provide leakage channels when elastomeric gasket compression fittings are used to make the joints.

Fittings shall be marked on the body or hub. Marking shall be in accordance with either ASTM D2683, ASTM D3261, AWWA C906, or ASTM F1055, depending on fitting type and the standard that applies. Mechanical fittings shall be marked with size, body material designation code, pressure rating and manufacturer's name or trademark.

I. **Workmanship**

Pipe, tubing, and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects. The pipe, tubing, and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical prosperities.

2.1.5 STEEL CASING PIPE

A. **Steel Casing Pipe**: Pipe shall be high strength steel, spiral welded or smooth-wall seamless manufactured in accordance with ASTM A139 *Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)* and ASTM A283/A283M *Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates* and consisting of grade "B" steel with a minimum yield strength of 35,000 psi. All encasement pipes shall meet the applicable NCDOT, Town, or AREA specifications but shall be no less than 6 inches larger than the outside diameter of the carrier pipe bell. The steel pipe shall be capable of withstanding the design load. No interior lining and exterior coating shall be required except that all exposed metal is to be coated with epoxy or asphaltic material. The pipe shall have welded joints and be in at least 18-foot lengths. Casing pipe shall include pipe carriers (Spiders) to support carrier pipe. The steel encasement pipe shall be of leak proof construction and shall include end caps.

B. **Casing Spacers/Insulators for Encasement Pipes**:

1) Spacers used to support and center carrier pipe and to insulate/catholically protect a pipeline from a casing pipe through which it must pass.

2) Band to be minimum 14-gauge, T-304 Stainless Steel with a minimum 10 ga. T-304 Stainless Steel riser and T-304 SS bolts, washers, and nuts. Liner on band to be EPDM.

3) Runners/Risers to be 1" or 2" wide glass filled polymer plastic; band lengths minimum 7" up to 12". All risers to be welded to the band by MIG welding. Unless otherwise noted on plans or specified, band is to have 4 equal legs for carrier pipe 16" and under; 5 legs for carrier pipe 18" to 24" and 6 legs for pipe 30" to 42". Stainless steel welds are fully passivated to prevent corrosion.

4) See **Standard Detail C07.01**. For bolted connections, bolts shall be either hot dipped galvanized or stainless steel and galvanically compatible with base metal.

5) See the Pre-Approved Product List (PAPL) for list of approved Casing Spacers/Insulators Manufacturers and model number.

C. **Steel Casing End Seals**: Casing end seals shall be 1/8" thick synthetic rubber seamless pull-on end seals with T-304 stainless steel banding with 100% non-magnetic worm gear mechanism. End seals shall permit pipe movement while maintaining a seal. See the Pre-Approved Product List (PAPL) for list of approved End Seal Manufacturers and model number.

D. **Carrier Pipe for Casings and Tunnels:** Carrier pipe shall be ductile iron pipe of the class indicated on the drawings.

2.1.6 TUNNEL LINERS AND APPURTENANCES

A. Grout mix for filling voids in between carrier pipe and tunnel shall consist of the following materials properly mixed in proportions by weight.

   1) 1.0 Part Cement.

   2) 3.0 Parts Fine Sand, 100 Percent Shall Pass No. 16 Sieve.

   3) 0.5 to 0.6 Part Water – water should be sufficient to provide a consistency of thick cream when well mixed.

   4) 2% approved additive (Bentonite, Septamine Seaex, Hydrocide liquid, etc.)

B. Tunnel lining construction shall comply with the "Specification for Steel Tunnel Liner Plates" in the American Railway Engineering Association Manual for Railway Engineering. The design and shape of the liner plates shall be such that erection and assembly of the liner plate structure can be completely and readily effected from inside the tunnel. Plates shall be accurately curved to suit the tunnel cross section, and all dimensions shall be of the size and accuracy that plates of similar curvature shall be interchangeable. All plates shall be connected by bolts on both longitudinal and circumferential joints.

C. The steel lining shall consist of plates 16, 18, or 24 inches wide. Each circumferential ring shall be composed of the number and length plates necessary to complete the required shape shown on the drawings. The nominal tunnel diameter shall be of sufficient size to install the carrier pipe.

D. Plates shall be one-piece steel meeting the requirements of ASTM A1011 *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*, or ASTM A1008 *Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable*. Plates shall have an ultimate tensile strength of at least 42,000 psi and yield strength of 28,000 psi. Nominal plate dimensions shall provide the sectional properties shown in Article 1.13.9 (or latest update) of the AASHTO Standard Specifications for Highway Bridges. Thickness tolerances shall conform to Paragraph 14 of AASHTO M167 *Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches*. Gage thickness shall be a minimum of 8 gage. The liner plate and bolts shall be galvanized in accordance with ASTM A153 *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*. In addition, the liner plates shall be asphalt coated to meet AREA Article 1.14.13 (or latest update). For two flange plates, the minimum thickness shall be 0.135 inches. Plates shall be manufactured by Armco Steel Corporation, Commercial Shearing, Incorporated, Republic Steel Corporation, or equal.

E. Grout holes 1½ inches or 2 inches (or larger) in diameter shall be provided in each ring to permit grouting as the erection of the tunnel liner plates progresses. Grout hole screw plugs shall be provided in plates.

   The minimum provision for grouting openings shall be one opening in a top plate of the tunnel at locations not to exceed 54" apart. Additional plates with grouting openings are to be installed at the top quarter points on each side between the top

openings. The opening shall be staggered, but shall not exceed 54" in any one line. Grout vent pipes will be required at a minimum of one per monolithic pour.

F. Steel bolts shall meet requirements of ASTM A449 *Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use* for plate thickness equal to or greater than 0.209 inch and ASTM A307 *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength* for plate thickness less than 0.209 inch. The nut shall meet requirements of ASTM A307, Grade A.

G. Steel casing pipe for boring through soil shall be grade B, meet requirements of ASTM A139 *Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)*, and have wall thickness to meet AREA Specifications. No interior lining and exterior coating shall be required.

2.1.7 CARRIER PIPE FOR CASINGS AND TUNNELS

Carrier pipe shall be mechanical joint ductile iron pipe with restraint gland of the class indicated on the drawings but no less than pressure class 350 psi (minimum thickness class 50), or an approved equal. See paragraph 2.1.2, Ductile Iron Pipe.

2.2 VALVES AND FIRE HYDRANTS

2.2.1 AIR RELEASE VALVE

Air release valves shall be 2-inch Pressure Air Release Valves with cast iron bodies, type 302 stainless steel floats, bronze trim and buna-n seats. Air release valves shall also meet AWWA C512. Size and location shall be as indicated on the drawings. Valves shall be rated for working and corresponding test pressure as indicated on the drawings. These valves shall be suitable for a minimum 200-psi working pressure but shall be no less than the working pressure indicated on the drawings. The valves are to be designed to allow air to escape automatically while the main is in service and under pressure. The valves are to relieve large volumes of air as the lines are filled and also release small quantities of entrained air under pressure. Air Release Valves to be NSF/ANSI 61/372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Air Release Valve Manufacturers and model number.

Manhole units shall consist of standard modular precast riser sections, modular riser sections, and a doghouse base. Where conditions do not favorably accommodate the use of an eccentric cone, eccentric precast reinforced concrete flat tops are to be used. See **Standard Detail 516.01**.

2.2.2 BACKFLOW PREVENTERS:

A. **Double Check Detector Assemblies (Sizes ¾" to 2"):** ASSE® Listed 1015, CSA® Certified, AWWA compliant C510, approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, Meets the requirements of NSF/ANSI/CAN 61. Low Lead Cast Bronze ASTM B 584 Main valve body & Access covers, Stainless Steel, 300 Series springs, and Silicone (FDA Approved) Buna Nitrile (FDA Approved) elastomers and Noryl™ polymers. Maximum working water pressure 175 PSI.

See the **Pre-Approved Product List** (PAPL) for list of approved Double Check Detector Assemblies (Sizes ¾" to 2") manufacturers and model number.

B. **Double Check Detector Assemblies (Sizes 3" to 10", OS&Y only) – Fire Protection Only:** All internal metal parts: 300 Series stainless steel, Main valve body: 300 Series stainless steel, Check assembly: Noryl® Flange dimension in accordance with AWWA Class D.

The bypass line shall be hydraulically sized to accurately measure low flow. The bypass line shall consist of a meter, a small diameter double check assembly with test cocks and isolation valves. The bypass line double check valve shall have two independently operating modular poppet check valves, and top mounted test cocks.

Unless permitted otherwise by the Engineering Director and the manufacturer for the application, detector check valves shall be installed in the horizontal position as long as the flow indicator arrow in the assembly is pointed in the direction of water flow.

The by-pass meter may be trimmed either right or left, coordinating with the direction of water flow. A meter trim package shall be furnished containing all nipples, bushings, elbows and related fittings needed to construct by-pass line. A meter shall be installed meeting these specifications. Set valve to allow minimal water flow though bypass meter when major flow is required.

The integrated supervisory tamper switch on the OSY model shall have continuity with the valve fully open and activate within two (2) turns from open. The device consists of two SPDT switches and is designed to send a tamper signal when the valve is closed and when the switch is removed from the valve. In the neutral position, the switch indicates the valve is fully open.

1) **Housing & Sleeve:** 300 Series Stainless Steel.

2) **Elastomers:** EPDM, Silicone, and Buna-N elastomers, Noryl™ polymers.

3) **Approvals:** ASSE® Listed 1048, AWWA compliant C510, UL 1469, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, DOES NOT Meet the requirements of NSF/ANSI/CAN 61; fire protection use only!

4) **OS&Y FxF Gate Valves:** Resilient seat gate valves shall comply with AWWA C515-09.· Body, bonnet, and wedge made of high strength ductile iron per ASTM A536 65-45-12. Flanged ends shall comply with the dimensional requirements of ANSI B16.1. Interior and exterior of the valves are fusion bond epoxy coated per AWWA C550. Epoxy powder is certified to NSF-61. Maximum working Pressure: 175 psi.

5) See the Pre-Approved Product List (PAPL) for list of approved Double Check Detector Assemblies (Sizes 3" to 10") manufacturers and model number.

C. **Reduced Pressure Principle Assembly[1] w/ Union Ball Valves (¾" to 2" RPZ):** ASSE® Listed 1013, CSA® Certified, AWWA compliant C511, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, Meets the requirements of NSF/ANSI/CAN 61. Low Lead Cast Bronze ASTM B 584 Main valve body & Access covers, Stainless Steel, 300 Series fasteners, and Silicone (FDA Approved) Buna Nitrile (FDA Approved) elastomers and Noryl™ polymers.

The assembly shall be rated to 175 PSI water working pressure and water temperature range from 32°F to 140°F. Shut-off and test cocks shall be full ported ball valves.

RPZ Backflow preventers are to be unique patent design of air-in/water-out principle high capacity relief valve discharge during the emergency conditions of combined back-siphonage and backpressure with both checks fouled meeting.

See the Pre-Approved Product List (PAPL) for list of approved RPZ Assemblies with Union Ball Valves (¾" to 2" RPZ) manufacturers and model number.

D. **Reduced Pressure Principle Assembly[2] BFP (3" to 10" RPZ):** The Reduced Pressure Zone Assembly shall consist of two independent torsion spring check modules, a differential pressure relief valve located between and below the two modules, two drip tight shutoff valves, and required torsion spring check modules and bottom mounted relief valve shall be contained with a sleeve accessible single housing constructed from 304 (Schedule 40) stainless steel pipe with groove end connections. Connecting OS&Y FxG/GxF gate valves. Maximum working Pressure: 175 psi.

RPZ backflow preventers shall be furnished and shall conform to the requirements of these specifications suitable for supply pressures of 175-psi and water temperatures of 110°F.

Reduced pressure detector assemblies are to be factory assembled and tested to assure proper mainline/by-pass balance and cross over performance.

1) **Housing & Sleeve:** 304 (Schedule 40) Stainless Steel.

2) **Elastomers:** EPDM, Silicone and Buna-N

3) **Approvals:** AWWA C511 Compliant, ASSE® Listed 1013, FM Approved, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California, UL Listed and FM approved Meets the requirements of NSF/ANSI/CAN 61 certified lead free.

4) **OS&Y Gate Valves - FxG/GxF:** Resilient seat gate valves shall comply with AWWA C515-09. Body, bonnet, and wedge made of high strength ductile iron per ASTM A536 65-45-12.· Interior and exterior of the valves are fusion bond epoxy coated per AWWA C550. Epoxy powder is certified to NSF-61.

[1] RPZ Backflow preventers are to be unique patent design of air-in/water-out principle high-capacity relief valve discharge during the emergency conditions of combined back-siphonage and backpressure with both checks fouled meeting.
[2] Ibid

5) See the Pre-Approved Product List (PAPL) for list of approved RPZ Assemblies (3" to 10" RPZ): and model number.

E. Unless otherwise allowed above for Fire Protection services (non-drinking water), all other backflow preventers are to be NSF/ANSI 61/372 certified lead free.

2.2.3 BALL VALVES: ¼ TURN STAINLESS STEEL BALL VALVES

2-inch and smaller (only allowed on PRV's): One-quarter turn stainless steel ball valves (used for air release valves) with NPT threaded ends (FNPT X FNPT), shall have a full port 316 stainless steel body, stems and balls with PTFE seals, seats and stem thrust bearing. Handles shall also be stainless steel. Valve shall be non-shock cold water rated for no less than 200-psi. See the Pre-Approved Product List (PAPL) for list of approved SS Ball Valve manufacturers and model numbers. See **Standard Detail 516.01**.

2.2.4 BUTTERFLY VALVES (16 inches and larger):

Butterfly buried service valves, for valve applications 16 inches and larger, shall meet AWWA C504, *AWWA Standard for rubber-seated butterfly valves* (Class 150B), mechanical joint with elastomeric body seats. Valves shall be short body and rated at no less than 150-psi. The Town may require installation of horizontal gate valves with a bypass assembly. All exposed nuts/bolts/hardware on all valves must be 304 stainless steel.

Butterfly valves shall be mechanical joint in accordance with AWWA C111. Accessories (bolts, glands, and gaskets) shall be supplied by the valve manufacturer.

All nuts and bolts shall be stainless steel.

Valve operators shall meet the requirements of AWWA C504 and shall be of the traveling-nut type, sealed, gasketed, and lubricated for direct-bury underground service. Valve operators shall be sized for the pressure indicated on the drawings. Operator shall be capable of withstanding an input torque of 450 ft-lbs. at full open or closed position, without damage to the valve or valve operators.

Valves shall be factory tested in accordance with Section 5 of AWWA C504 specification. Upon request the manufacturer shall furnish certified copies of test reports.

Valves shall open counter-clockwise (left) with indicator and shall be equipped with a 2-inch square AWWA operating nut.

Valves shall be coated interior with fusion bonded thermosetting plastic, rubber, or epoxy. The exterior of buried valves shall also be bituminous or asphalt coated. Valve to be NSF/ANSI 61, NSF/ANSI 372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Butterfly Valve manufacturers and model numbers.

All resilient seat gate valves furnished for a project shall be from the same manufacturer.

Butterfly valves shall be placed in a minimum 5-foot diameter precast concrete manhole. See **Standard Detail 513.09**, sheet 1.

2.2.5 CHECK VALVES (3” through 12”)

All Swing Type Lever and Weight Check Valves used for pressure zone separation (above ground applications) shall be iron body; with a bronze disk facing, ASTM A126 *Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings* construction, bronze mounted with flanged ends as noted on the drawings. The shaft shall be 304 stainless steel and the seat ring shall be of bronze with an easily replaceable resilient disc seat. The valve shall be tight seating.

Check valves shall be non-slamming (shock absorber) type. Check valves for above ground applications shall be equipped with an outside lever and weight (adjustable weight control), with an external bronze cushion chamber, air operated, unless otherwise noted on the drawings (when more positive control is needed, the lever-and-spring may be specified). Valves 16" to 24" shall have a minimum non-shock cold-water pressure rating of 200 psi minimum maximum working pressure, 400 psi test pressure. The valve body shall be epoxy coated on the interior and exterior.

Flanged check valves shall meet the dimensional requirement of ANSI B16.1 and meet or exceed the requirements of ANSI/AWWA C-508. Flanged ends shall be provided with bolts and gaskets.

When check valves are used in vault applications, a ball drip valve is to be provided.

All check valves shall be furnished with an arrow cast into the body indicating the direction of flow during system operation.

Check valves to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Check Valve manufacturers and model numbers.

2.2.6 GATE VALVES

A. **Gate Valves, Resilient Wedge (2 inches through 12 inches)**: All gate valves shall be iron body of the resilient wedge type complying with AWWA C509 or AWWA C515 and shall be UL listed and FM approved for a working pressure of 200 psi. All internal parts shall be accessible without removing the body from the line. The wedge shall be of cast iron completely encapsulated with resilient material. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber tearing bond to meet ASTM D429 Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates and AWWA C550.

Non-Rising Stems (NRS) shall be cast bronze with internal collars in compliance with AWWA. OS&Y stems shall be bronze. The NRS stuffing box shall have two "O"-Ring seals above the thrust collar. These rings shall be field replaceable without removing the valve from service.

Each valve shall be hydrostatically tested at 400-psi to the requirements of both AWWA and UL/FM.

All gate valves 4 through 12 inches shall be of the mechanical joint type (except in vault/above ground application the joints shall be flanged end). 2-inch gate valves shall have iron pipe threads.

All exposed nuts and bolts shall be stainless steel.

Valves shall open counter-clockwise (left) and shall be equipped with a 2-inch square AWWA operating nut.

The valve body and bonnet shall be coated interior and exterior with fusion bonded thermosetting plastic or epoxy.

All resilient seat gate valves furnished for a project shall be from the same manufacturer.

Gate valves to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Resilient Seat Gate Valves (2" through 12") manufacturers and model numbers.

B. **Gate Valves, Resilient Wedge (16 inches and larger)**: Valves shall be iron body of the resilient wedge type complying with AWWA C509 and shall be UL listed and FM approved for a working pressure of 250-psi. Valves shall meet or exceed the requirements of AWWA C515. Valve body, bonnet, wedge, and operating nut shall be constructed of ductile iron. The exterior of the ductile iron wedge shall be fully encapsulated with rubber. The resilient sealing material shall be permanently bonded to the ductile iron wedge with a rubber tearing bond to meet ASTM D429 Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates and AWWA C550. Non-buried valves shall have all internal and external surfaces of the valve body and bonnet shall have a fusion-bonded epoxy coating complying with AWWA C550, applied electrostatically prior to assembly.

Non-Rising Stems (NRS) shall be cast bronze with internal collars in compliance with AWWA. Stem and stem nut shall be high-strength bronze. Stem shall be sealed by three O-rings. The NRS stuffing box shall have the top two O-ring seals shall be replaceable with valve fully open and while subject to full rated working pressure. O-rings set in a cartridge shall not be allowed. Valve shall have thrust washers located with 1 above and 1 below the thrust collar to ensure trouble-free operation of the valve.

Each valve shall be hydrostatically tested at 500-psi to the requirements of both AWWA and UL/FM.

All gate valves shall be of the mechanical joint type (except in vault/above ground application the joints shall be flanged end).

All exposed bolts and nuts shall be stainless steel.

Valves shall open counter-clockwise (left) and shall be equipped with a 2-inch square AWWA operating nut.

All resilient seat gate valves furnished for a project shall be from the same manufacturer.

Gate valves 16 inches and larger shall be placed in a precast concrete manhole. See **Standard Detail 513.09**.

Gate valves to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Resilient Seat Gate Valves (16" and larger) manufacturers and model numbers.

C. **Inserting Valves**: Inserting valves shall meet requirements of gate valves specified above for valve mechanism and AWWA C110/ANSI A21.10 for the sleeve for pressure ratings shown on the drawings.

2.2.7 TAPPING SLEEVES AND VALVES (STAINLESS STEEL)

The tapping sleeve and valve shall be suitable for wet installation without interrupting water service.

The sleeve and gasket shall provide full wrap-around (360 degree) pipe coverage, Mechanical Joint tee outlet. Stainless Steel Tapping Sleeves to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

Stainless Steel Tapping Sleeve: AWWA C223 *Fabricated-Steel and Stainless-Steel Tapping Sleeve* with a mechanical joint outlet tee. Sleeve body, flange, bolts, nuts, test plug, and any other structural components shall be constructed of Grade 18-8 Type 304 stainless steel, The sleeve and gasket shall provide full wrap-around (360 degree seal) pipe coverage with a full gasket of gridded (waffle). Gasket to be made of virgin NBR (R78) material. An integral sealing ring with two concentric raised surfaces surrounds the outlet (at the base of the pipe).

150 psi minimum working pressure with a maximum working pressure of 250-psi for sizes 4" through 12" and 200-psi for sizes 14" through 24".

Always pressure test tapping sleave and valve for leaks before making tap.

Gate valves to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

Use of ductile iron tapping sleeves must be approved by the Engineering Director.

See the Pre-Approved Product List (PAPL) for list of approved Stainless Steel Tapping Sleeve manufacturers and model numbers.

See **Standard Detail 513.02**.

Tapping Valves: Resilient seat tapping valves shall be epoxy coated (minimum 10-mil thickness) and otherwise meet the requirements of Part 2- PRODUCTS, *Gate Valves*, paragraph 2.2.6 except that the seat openings shall be larger than nominal size with a raised alignment ring on the flange. Valve ends shall be mechanical joint by flange (MJxFL). Valves shall open counter-clockwise (left) and shall have a 2-inch operator nut. See **Standard Detail 513.02**.

All bolts and nuts are to be stainless steel.

Tapping valves shall be "O" ring type mechanical joint end conforming to AWWA non-rising stem construction. Inlet flange end shall be Class 125 (ANSI B16.1).

See the Pre-Approved Product List (PAPL) for list of approved Resilient Seat Gate Valve manufacturers and model numbers.

2.2.8 FIRE HYDRANTS

A. **Fire Hydrants**: Fire hydrants shall comply with ANSI/AWWA C502 *Dry-Barrel Fire Hydrants*, latest revision, UL 246 and FM1510, AWWA C550, 6" MJ inlet, 5-1/4" foot valve, with (1) 4 ½-inch steamer nozzle with auxiliary straight pattern Storz Fire Department Connection and (2) 2 ½-inch nozzles with NS threads (American National Thread-Special), 1-½" open counterclockwise (left) pentagonal operating nut. See **Standard Details 514.04** and **514.05**.

Interior coating to be in accordance with AWWA C550. Minimum working pressure shall be 150-psi.

B. **Hydrant Elbow w/ Mueller AquaGrip System - Approved Option to wedge action joint restraint**: Fire Hydrants are to include the Mueller AquaGrip® System connection and restraint at the hydrant/valve bell. The AquaGrip® System connecting to hydrant elbow is to be compatible with ductile iron pipe, both C900 and C909 PVC pipe, UL listed, FM approved, and NSF/ANSI 61, NSF/ANSI 372 certified lead free. The AquaGrip® System is to meet the performance requirements of ASTM F1674 and ISO 14236-2. Fitting to be of Ductile Iron construction with fusion bonded epoxy coating and shall include fully assembled stab connection with break-away nuts, gripper ring, and a pressure responsive double O-ring. Maximum working pressure up to 250 psi.

C. Hydrants shall consist of the following:

1) Two 2½-inch fire nozzles and one 4½-inch steamer nozzle, National Standard hose threads.
2) The steamer nozzle shall be provided with an auxiliary straight pattern Storz Fire Department connection. Storz unit to be hard coated aluminum construction Guardian 6600 series Storz Fire Department Connection, Female NPT x Locking Storz Inlet with Storz blind Cap. Storz cap to include securing chain.
3) All nozzles shall be provided with caps and chains.
4) The hydrant foot valve opening shall be 5¼ inches.
5) Hydrant to be dry top with lubrication reservoir.
6) Bronze to bronze threads shall be provided between the hydrant seat or seat ring and the seating attaching assembly. Seat ring to shoe shall be bronze to bronze.
7) All hydrants must include cast or ductile epoxy lined shoe (minimum 4 mils), rubber drain seals and positive protective valve stop device.
8) Hydrants shall open left and shall have a National Standard pentagon-type operating nut (1 ½" point to flat). The operating nut shall be of one-piece bronze construction. A thrust washer shall be supplied between the operating nut and stem lock nut. The valve stem shall have a safety flange and a safety coupling.
9) Hydrants shall have a Mueller AquaGrip® Connection/Restraint System at hydrant elbow, as noted in paragraph B above, or a restrainer gland with a

mechanical joint elbow. A 6-inch hub-end may be used only with the approval of the Engineering Director.

10) The hydrant barrel shall be of sufficient length to provide a minimum bury of 3 feet.
11) Hydrants shall be of the compression type closing with line pressure and shall be of the traffic model breakaway type.
12) Hydrant cap and stuffing box shall be of unitized, one-piece design creating a watertight cavity without the use of gaskets. The combination of O-Rings to a crimped brass ferrule around the stem shall seal the cavity from contact with water. Hydrant caps shall have a means for providing periodic lubrication of the operating threads.
13) The main valve shall be of synthetic rubber reinforced with steel. The seat shall be of a bronze ring threaded to a bronze insert in the hydrant shoe, with O-Rings to seal the drain way and barrel from leakage of water in the shoe.
14) The hydrant drain hole shall momentarily force flush with each operation.
15) All hydrant extension kits, flange kits, stems, couplings or other repair parts must be of the original hydrant manufacturer. Only one 24-inch extension kit is allowed.
16) Public hydrants shall be painted with 2 coats of Sherwin Williams, or approved equal, Federal Safety Red paint (barrel & bonnet) in accordance with **Standard Detail 514.04** and **514.05**.
17) If line is to be pressurized within 7 days of setting hydrant, then 4000-psi high early strength concrete shall be used.

All hydrants furnished for a project shall be from the same manufacturer.

Fire Hydrants to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

See the Pre-Approved Product List (PAPL) for list of approved Fire Hydrant manufacturers and model numbers.

See paragraph 3.2.5, Fire Hydrants for installation requirements.

2.2.9 BLOW OFFS

Temporary Blow-Off Assembly for Future Extension: Blow-off assemblies for future extensions shall consist of three standard valve boxes with two precast concrete valve box pads, a thrust collar, a mechanical joint plug tapped for 2-inches, a 2-inch brass pipe riser with a 2-inch threaded male threaded plug. See **Standard Detail 514.01**).

2.2.10 CORPORATION STOPS

Corporation stops for ¾-inch through 1-inch taps only: AWWA C800, NSF/ANSI 61 and NSF/ANSI 372 certified lead free, Ball Valve, 300 psi working pressure, all bronze CC tapered threaded inlet by compression copper outlet. All services require a double strap bronze saddle.

2-inch corporation stops are not permitted.

See **Standard Details 513.04 and 519.01**.

See the Pre-Approved Product List (PAPL) for list of approved Corporation Stop manufacturers and model numbers.

2.3 MISCELLANEOUS APPURTENANCES

2.3.1 BEDDING

Bedding material, when specified, shall be clean coarse aggregate No. 57 or No. 67 and shall meet the requirements of Table 1005-1, *Aggregate Gradation, Coarse Aggregate* of the *NCDOT Standard Specifications for Roads and Structures*, latest revision.

2.3.2 CAST STRAIGHT AND TRANSITION COUPLINGS (REPAIR COUPLINGS)

A. Couplings shall be of a gasketed, sleeve type. Couplings shall be of the type to match piping on which installed. End rings and center rings are cast from ASTM A536 Ductile Iron, Sleeve type coupling w/ Styrene Butadiene Rubber (SBR) gaskets meeting ASTM D2000 MBA 710. Minimum working pressure to be 150 psi working pressure. Coatings to be fusion bonded epoxy. Bolts to be stainless steel.

B. **Top Facing Single-Bolt Coupling:** ASTM A53 Grade A Steel with EPDM compounded per ASTM D2000, 100% fusion bonded epoxy for enhanced corrosion protection, average thickness = 14 mm. End rings to meet ASTM A283 Grade C steel. Connects two pipes of the same or different OD pipes and materials, up to 1.3" range. Bolts to be stainless steel.

C. **All couplings** to meet or exceed AWWA C219. All couplings to be NSF 61 and NSF 372 certified lead free.

D. **Note:** Flexible couplings do not restrain axial forces on piping.

Each coupling shall consist of a steel middle ring, two steel followers, two rubber compounded wedge section gaskets and sufficient track head stainless steel bolts to properly compress the gaskets.

See the Pre-Approved Product List (PAPL) for list of approved Cast Coupling manufacturers and model numbers.

2.3.3 WARNING TAPE

A. **Metallic Underground Warning Tape:** Metallic detectable underground warning tape shall consist of a solid aluminum foil core, minimum 0.35 mil foil thickness, encased on each side with plastic (minimum overall thickness 5 mils) and be 3 inches wide with black lettering imprinted on a color coded background that conforms to APWA uniform color code specification (BLUE) and silver with black ink letters. Minimum tensile strength shall be 22 lbs./inch. Soil tolerance range to be pH 2.5 to pH 11.0. On one side of the tape, the text shall include the wording "WATER (or a SEWER force main, if applicable) LINE BELOW" repeated along the length of the tape. A detectable warning tape shall be used with all water and sewer force mains. See **Standard Details 511.01, 531.01, 531.02,** and **531.03**.

See **Pre-Approved Product List** for approved manufacturers and product numbers.

Standard color code for tape and wire.

Blue: Water Systems

2.3.4 RFID MARKER BALLS RFID* Marker Balls with iD Read/Write *(Radio Frequency ID): See paragraph **2.2.4 of Specification Section 02275** *Utility Trenching, Backfilling and Compaction of Utilities*.

2.3.5 DUCTILE IRON TRANSITION COUPLINGS

Transition couplings shall be ANSI/NSF 61 and ANSI/NSF 372 certified lead free, fusion bonded powder epoxy coating and constructed of ASTM A-536, grade 65-45-12 ductile iron flanges and middle ring. Bolts are to be stainless steel 18-8 Type 304. Transition couplings are to accommodate IPS PVC, C-900 PVC, Ductile Iron Pipe, Cast Iron, and Asbestos Cement Classes 100/150/200. See paragraph 2.3.2 Cast Straight and Transition Couplings, above.

2.3.6 RESERVED

2.3.7 MANHOLE FRAME AND COVERS

Manhole frames and covers shall be manufactured from Class 35B gray iron, meeting the requirements of ASTM A48*, Standard Specification for Gray Iron Castings,* AASHTO M 105, and as noted in section 3.1 of AASHTO M 306. Standard manhole frames and covers shall be built to the dimensions and configurations shown on **Standard Detail C06.01.** Minimum inside diameter of the opening shall be 23 ½ inches. Manholes castings are to be uncoated. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Covers are to be embossed along the perimeter with the name “TOWN OF CLAYTON.” Cover shall read “WATER” in the center and “CONFINED SPACE” around the circumference.

Weights shall not vary more than 5% +/- of the weight shown on **Standard Detail C06.01**.

See **Pre-Approved Product List** for approved iron casting manufacturers and product numbers.

2.3.8 MISCELLANEOUS CONCRETE WORK

Concrete classes (NCDOT) to Design compressive Strength at 28 days (f’c):

Class	28-day Compressive Strength (f’c)
AA	4500 psi
A	3000 psi

*See also Table 1000-1 of *NCDOT Standard Specifications for Roads and Structures, latest revision*

Unless otherwise indicated on the project drawings or directed by the Engineering Direction, concrete shall be a minimum of 3000 psi concrete at 28 days. Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete.* This applies to concrete blocking, valve box stabilizing pads,

thrust collars, concrete encasement, and Fire Hydrant setting and thrust pads. All exposed concrete shall be air entrained.

2.3.9 PRECAST CONCRETE MANHOLE STRUCTURES (Base, Riser Section, Top Section, Grade Rings)

Structures of precast reinforced concrete manholes shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, latest revision ("O" ring joints) or AASHTO M 199 (gasketed joints). The standard joint shall be sealed with plastic cement putty meeting Federal Specification FS SS-S-00210 (210-A), ASTM C990, Type 1, Rope Form, ¾" diameter (min.).

An "O" ring or "mastic" joint seal may be used. The "O" ring joint shall conform to the requirements of ASTM C443 *Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets or* AASHTO M198 *Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Seala*nts.

Concrete used in the construction of the manholes shall have a minimum 28-day compressive strength of 4000-psi (with 4 to 6 percent air), type II cement, conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Manholes shall have eccentric flat top as applicable. See **Standard Detail 516.01**.

Structures are not permitted to have steps.

Manhole Size Determination:

a. Unless shown otherwise, the minimum diameter of manholes shall be 5 feet.
b. Manholes with 16-inch diameter or larger pipe shall be a minimum of 6 foot diameter.

See **Pre-Approved Product List** for approved pre-cast concrete manhole manufacturers and product numbers.

2.3.10 PRECAST UNDERGROUND CONCRETE UTILITY STRUCTURES

Structures of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C858, *Standard Specification for Underground Precast Concrete Utility Structures*, latest revision with preformed butyl rubber joint sealant meeting ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed flexible Joint Sealants*, latest revision and ASTM C913 *Standard Specification for Precast Concrete Water and Wastewater Structures,* Type II cement *(*with the exception of concrete pipe, box culverts, utility structures, septic tanks, grease interceptor tanks, and items included under the scope of Specification C478). Type Concrete used in the construction of the Utility Structures shall have a minimum 28-day compressive strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Supply deformed steel bar reinforcement conforming to ASTM A615 for Grade 60. Unless shown otherwise on the drawings, structures are not to have steps. Steel reinforcing shall conform to the requirements of ASTM C857, *Standard Practice for Minimum Structural Design*

Loading for Underground Precast Concrete Utility Structures, latest revision. Structures shall be designed for an HS20 loading in traffic areas.

See **Pre-Approved Product List** for approved pre-cast concrete manhole manufacturers and product numbers.

2.3.11 PIPE SADDLE SUPPORT - ADJUSTABLE

Adjustable Pipe Saddle Support - For Dry Conditions - 2½-inch through 36-inch pipe: Material to be cast iron saddle formed to ductile iron pipe, with lock nut, and special cast iron reducer. Vertical adjustment range to be from 0 up to 4½ inches. Cast iron stanchion saddle with steel yoke and nuts; 14" through 36" carbon steel saddle with steel yoke; 4" through 12" steel saddle. Adjustable pipe saddle supports shall comply with Federal Specification A-A-1192A (Type 37), ANSI/MSS SP-69 and MSS SP-58 (Type 37).

Adjustable Pipe Saddle Support For Wet or Harsh Corrosive Conditions 2-inch through 24-inch pipe: Material to be steel saddle formed to ductile iron pipe, lock nut, and special steel reducer. Vertical adjustment range to be from 0 up to 4½ inches.

A. Saddle strap to meet ASTM A36 *Standard Specification for Carbon Structural Steel*. Base Plate to meet ASTM A36 sheet steel, 0.25-inch.
B. Collar and base cups to meet ASTM A53 *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless* D.O.M. tubing and ASTM A513 tubing *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.*
C. Thread stud: Grade ASTM A307 *Standard Specification for Carbon Steel Bolts and Studs, 60,000-PSI Tensile Strength*.
D. Finish:
    i. Finish to be hot dipped galvanized unless Engineering Director requires stainless steel. In the latter case, material to be 100% 304 stainless steel with saddles formed of ductile iron pipe.
    ii. Provide neoprene liner to isolate pipe from saddle.

See **Pre-Approved Product List** for approved Adjustable Pipe Saddle Support manufacturers and product numbers.

2.3.12 SERVICES

Copper tubing, yokes, service saddles, meters, and appurtenances, through which potable water shall flow or contact, are all to be NSF/ANSI 61 and NSF/ANSI 372 certified lead free.

A. **Small Services: 3/4-inch and 1-inch Water Services**:

Seamless Type K Copper, soft drawn; comply with ASTM B-88, *Standard Specification for Seamless Copper Water Tube*, FS WW-T-799, latest revision. (2-inch and smaller pipe). Services shall be ¾-inch to 1-inch and shall be one continuous run from main to meter with no joints or couplings in between. On these water services, the fittings shall be brass AWWA C-800, compression copper type fittings. See **Standard Details 513.04** and **519.01**.

Taps shall be made with a service saddle.

Service Saddles: Saddles shall be all bronze saddle with a double bronze strap and a grade 60 neoprene "O" ring gasket attached to the body, 150 psi working pressure minimum. The saddle casting, straps, and nuts shall be water works bronze 85-5-5-5. The saddle shall have CC tapered corporation stop threads. See **Standard Detail 513.04**.

See **Pre-Approved Product List** for approved service saddle manufacturers and model numbers.

5/8 x 3/4-inch and 1-inch meter setter/yoke: 5/8-inch x ¾-inch and 1-inch meter setters/yokes shall conform to AWWA C800 (ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings and ASTM B584 Standard Specification for Copper Alloy Sand Castings for General Applications, UNS NO C83600 - 85-5-5-5 Brass) and be factory tested for water-tightness before shipping. Setters shall be comprised of all brass and copper padlock wing stop inlet ball valve (lockable cut-off), angle double check outlet valve, with inlet and outlet copper connections and a 12-inch rise. See **Standard Detail 519.01**.

See **Pre-Approved Product List** for approved meter setter/yoke manufacturers and model numbers.

Polymer Meter Box and Lids: Meter boxes shall be 12-inch deep boxes. Meter Box and Lid (5/8" x ¾" and 1" meter services); Solid black polymer lid ordered predrilled for AMR/AMI remote readout. H/20 poly lid w/ 2 pcs #5 rebar cast inside lid, recessed hole for Sensus Antenna. Meter boxes shall be supported on 4 standard concrete bricks, which shall in turn be supported by a minimum of 3 to 4 inches of #57 or #67 washed stone. One standard solid brick shall be placed vertically on each end of the box over the inlet/outlet slot. Boxes shall be set in such a manner that the centerline of the meter shall be 7 inches below the top of the box and shall provide adequate clearance for the meter. All meter boxes shall also be backfilled and supported outside the box with fine graded sand. The Town will not set water meters until such time as meter setters are set level and boxes are set to proper grade. Unless a traffic model box is used, meter boxes shall not be installed in driveways, roads, closer than 3 feet to a fire hydrant, and shall not be installed in parking lots or sidewalks unless shown on the plan or prior approvals are obtained from the Engineering Director.

Meters:
Displacement meters shall comply with the most current AWWA C710 *Cold-Water Meters-Displacement Type, Plastic Main Case* and meets the requirements of NSF 61, Annex G and NSF 372. Meters shall be compatible with AMI (Advanced Metering Infrastructure) systems. Main case and bottom plate material - Composite. Maximum operating pressure = 150 psi. Registers to read in 100's of gallons.

See **Pre-Approved Product List** for approved meter manufacturers and model numbers.

B. **2-Inch Water Services:**

Type K Copper, soft drawn; comply with ASTM B-88, *Standard Specification for Seamless Copper Water Tube*, FS WW-T-799, latest revision. Water service pipe for 2-inch connections shall be type "K" seamless soft drawn copper with compression type joints with brass fittings and shall be one continuous run from

main to meter with no joints or couplings in between. On these water services, the fittings shall be compression type brass fittings.

The service line for a 2-inch meter shall consist of a 2-inch tap (whether a 1 ½" or 2" meter), 2-inch type K soft drawn copper service line, a threaded x compression adapter, and two 2-inch threaded Iron Body Gate Valves (one gate valve at the tap and one gate valve on private side of meter box), and a 2-inch x 4-inch long threaded (iron pipe thread) brass nipple at service tap (see sheet 3 of **Standard Detail 519.03**). No joints allowed between main and meter box. See **Standard Detail 519.03**, sheets 1 through 3.

See **Pre-Approved Product List** for approved iron body gate valve manufacturers and models numbers.

Service saddles: Service saddles shall be 2-inch all bronze saddle with double bronze straps and with a grade 60 neoprene "O" ring gasket attached to the body, 150 psi working pressure minimum. The saddle casting, straps, and nuts shall be water works bronze 85-5-5-5. The saddle shall have 2-inch iron pipe threads. See **Standard Detail 519.03**, sheet 3.

See **Pre-Approved Product List** for approved service saddle manufacturers and model numbers.

2-inch meter setter/yoke: Meter Setters shall conform to AWWA C800 (ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings and ASTM B584 Standard Specification for Copper Alloy Sand Castings for General Applications, UNS NO C83600 - 85-5-5-5 Brass) and copper tubing, and factory tested for watertightness before shipping. 2-inch meter setter/yoke with 18-inch rise shall be comprised of all brass and copper padlock wing inlet ball valve (lockable cut-off), angled double check valve, 1 ¼-inch by-pass line with a 1 ¼-inch stop ball valve, in-line double check valve, stabilizer bars, and brace pipe eyelets for 1-inch pipe. Outlet connections are to be compression. See **Standard Detail 519.03**.

See **Pre-Approved Product List** for approved meter setter/yoke manufacturers and model numbers.

Meter Boxes, Standard Cast Iron, 18"x30": Meter boxes shall be cast iron, meet ASTM A48 Class 35B and have the same approximate weight as, and lids interchangeable with, the MBX-5A as manufactured by Capitol Foundry for 2-inch meters. Lid to be labeled "Town of Clayton" and "Water Meter." Provide 2" hole in lid for antenna.

Meter boxes shall be supported on two or more rows of standard 4"x8" concrete bricks, which shall in turn be supported by of #57 or #67 washed stone as required for support of brick and bypass. One standard solid brick shall be placed vertically on each end of the box over the inlet/outlet slot. Meter must be level across meter connections and set with top of setter at 12 inches below cover. Unless a traffic model box is used, meter boxes shall not be installed in driveways, roads, closer than 3 feet to a fire hydrant, and shall not be installed in parking lots or sidewalks unless shown on the plan or prior approvals are obtained from the Engineering Director. The Town will not set water meters. Meters will be supplied and set by the developer.

See **Pre-Approved Product List** for approved standard cast iron meter box manufacturers and model numbers.

C. **Large Meter Services (3-inch and larger)**

Piping: For services greater than 2 inches, the water service pipe shall be 4, 6, 8, 10, or 12 inches in diameter and shall be constructed of ductile iron pipe. 3-inch diameter pipe is not allowed in the Town's distribution system. 3-inch meters shall be served by a 4-inch tap and 4-inch service line. Ductile iron fittings shall be used on these services. Taps on existing lines may be made by using the appropriate size tapping sleeve and valve. On a new line, the connection shall be made with a tee and valve.

Large Meter Vaults:

1. Meter vaults for 3" and 4" compound meters and meter vaults for meters larger than 4" shall be constructed of precast concrete with a floor drain with a connection that is compatible with 4-inch diameter ductile iron pipe. Meter vault floors shall be sloped toward the drain. Sump pumps are not permitted unless a written request is approved by the Engineering Director. In the event that there is insufficient negative grade from the vault to daylight, an above ground meter vault may be used.

2. Meter vaults shall have aluminum, cast-in-place hatches with spring-loaded doors with slam locks. Doors shall be lockable by padlock using a factory built-in steel pin or angles.

3. The vault doors shall be located over the water meter. Hatch opening to be sufficient to allow pulling meter out of access opening in the horizontal position but no less than 36 inches by 36 inches square in dimension.

4. See specification section 2.3.15, *Vault Access Hatch*, below.

5. Vaults may be either precast or, with the approval of the Engineering Director, cast-in-place (certain design and construction criteria will apply with cast-in-place vaults that necessitate review and approval). See paragraph *2.3.10 Precast Underground Concrete Utility Structure* for specifications governing precast meter vaults.

6. See **Standard Details 519.04** and **519.05**.

See 02275 – *Trenching, Backfilling and Compaction of Utilities*, paragraph 3.3.2 C for bedding requirements for Structures. Starting at 12 inches above the meter, vaults shall have steps spaced 12 inches on center from the vault lid downward toward meter. Minimum meter vault dimensions shall be as follows below.

Meter Size	Minimum Vault Size
3-inch	8'-6" L x 6'-0" W x 6'-6" H
4-inch	10'-0" L x 8'-0" W x 6'-6" H
6-inch	10'-0" L x 8'-0" W x 6'-6" H
8-inch	12'-0" L x 9'-0" W x 6'-6" H

Combinations Vaults: Combination vaults shall be designed and constructed to provide the following minimum clearances between the pipe, fittings or vault walls:

Conflict	Minimum Clearance (inches)
Vault bottom or side wall to side of pipe, valve or meter	12
Vault end wall to nearest bolted connection	12
Pipe to pipe, fitting or valve	18
Top of OS&Y valve stem (fully opened) to vault ceiling	4

See sheet 1 of **Standard Details 519.04** and **519.05**.

Meters:

1. The Sensus OMNI+ C2 meter meets and far exceeds the most recent revision of AWWA Standard C701 and C702 class II. Additionally, the meter does not require a valve to meet these standards. Each meter is performance tested to ensure compliance. All OMNI meters are NSF/ANSI Standard 61, Annex F and G approved latest standards. The OMNI+ C² meter consists of two basic assemblies; the main case and the measuring chamber. The measuring chamber assembly includes the "floating ball" impeller with a coated titanium shaft, hybrid axial bearings, integral flow straightener and an all-electronic programmable register with protective bonnet. The main case is made from industry proven Ductile Iron with an approved NSF epoxy coating. Main case features are easily removable measuring chamber, unique chamber seal to the main case using a high-pressure O-ring, testing port and an AWWA compliant strainer.

2. Up-flow Integral Strainer: Meters to be provided with strainers upflow. The OMNI+ C² with the AWWA compliant "V" shaped strainer, with removable strainer cover, uses a stainless steel screen along with Floating Ball Technology (FBT) on the upflow (inlet end). The removable strainer cover is to permit easy access to the screen for routine maintenance.

3. Meters and Electronic Registers are compatible with current Sensus AMR (Automated Meter Reading) systems and other AMI communication systems that use the Sensus UI1203 protocol. 200 psi maximum operating pressure.

4. Registers to read in 100's of gallons.

5. Turbo meters shall only be used in irrigation applications when approved by the Engineering Director.

6. See **Pre-Approved Product List** for approved meter manufacturers and model numbers.

D. **Meter Setting**

For meters 3-inch and above, upon conditional approval of the construction drawings, all fees will be invoiced by Development Services to include all water

meter(s) required for the site. Upon payment by the Developer, the Town will furnish water meter(s) to the Contractor. The Contractor will install water meters.

E. **Residential & Commercial Services – A Note to Developers/Contractors:** Unless otherwise approved by the Engineering Director, Residential and Commercial water and sewer services should be installed together per **Standard Detail C07.03.**

2.3.13 TIE-RODS

A. **Stainless Steel All Thread Tie Rods:** Stainless steel all-thread tie rods, plate washers, and heavy hex nuts (ASME B18.2.2) shall be type 316 or T316 Stainless Steel all-thread rods meeting ASTM A193, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications* and meeting ASTM F593 *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs,* ASTM F594 *Standard Specification for Stainless Steel Nuts,* and ASTM A751 (Chemical). No duck lugs will be allowed.

B. **Threads**: All parts shall be the coarse threaded series as specified in the latest issue of ANSI/ASME B18.2.1.

C. **Tensile Strength**: ¼" to 5/8" diameter to be 100 ksi min. to 150 ksi max.; ¾" to 1 ½" diameter to be 85 ksi to 140 ksi max.

D. **Minimum Yield Strength**: 45 ksi

2.3.14 VALVE BOXES

Heavy duty 5 ¼" shaft screw-type valve boxes bituminous coating shall be U.S.A. made gray cast iron of the dimensions shown in **Standard Detail 513.01**. Gray Iron valve boxes shall meet ASTM A48 *Standard Specification for Gray Iron Castings*, Grade 35B and AASHTO M306 *Drainage, Sewer, Utility and Related Castings*, Heavy Duty. Slide or slip type valve boxes are NOT acceptable.

Lids shall be heavy duty traffic weight with the word "water" cast into the lid. Provide cast-iron screw-type telescoping top section of length required for depth of burial of valve and bottom section with base of size to fit over valve.

See Pre-Approved Product List for approved valve box manufacturers and model numbers.

2.3.15 VAULT ACCESS HATCH

A. **Non-Traffic Areas**: Non-traffic rate aluminum hatches are to be one-piece aluminum extruded frame with a continuous concrete anchor as part of the one-piece extrusion. The aluminum access frames and covers are manufactured with 1/4-inch thick aluminum diamond plates and capable of withstanding a live load of 300 lbs. per square foot, with a safety factor of times 1.5.

1. The doors are provided with spring-loaded doors, stainless steel hinges with tamper-proof fasteners. All hardware is to be stainless steel.

2. Doors larger than 36"x36" shall be double leaf doors.

3. The doors shall open to 90 degrees and lock automatically in that position with a stainless steel positive locking arm and a stainless steel release handle.

4. Doors are to be provided with a stainless steel lifting handle, stainless steel locking bar.

5. The doors will close flush with the top of the frame, resting on a 1/2-inch wide lip around the entire inside of the frame for added support.

6. Doors shall be lockable by padlock hasp using a factory built-in steel pin or angles. Vaults in pedestrian areas shall have recessed latch.

7. Hatches to be equipped with fall protection grating system features meeting OSHA fall protection standards.

8. See **Standard Details 519.04** and **519.05**.

B. **Traffic Areas** – Vaults are not permitted in traffic areas.

C. **Guarantee and Manufacturer**: The aluminum access frames and covers shall carry a 10-year guarantee against defects in materials and workmanship.

See **Pre-Approved Product List** for approved vault access hatch manufacturers and model numbers.

PART 3 – EXECUTION

INSTALLATION – PIPE AND FITTINGS

3.1 PIPE & FITTINGS

Refer to Section 02275, TRENCHING, BACKFILLING AND COMPACTION OF UTILITIES.

3.1.1 DUCTILE IRON PIPE

A. **DIP Installation**

1) **Trenching & Bedding**: Refer to Section 02275, *Trenching, Backfilling, and Compaction of Utilities*.

2) **Installation of DIP Water Mains**: Comply with AWWA C600, *Installation of Ductile Iron Water Mains and Their Appurtenances*.

3) **Pipe Laying - Separation**: The contractor shall comply with the NCDEQ standards for separation of water mains from sanitary sewers or storm drainage lines. See Part 1 – GENERAL, *paragraph 1.9 – Project Conditions* of this specification. See also **Standard Detail C01.05** for a visual depiction of the separation requirements.

4) **Materials, Storage, and Handling:** See paragraph 1.7 – *Product Delivery, Storage and Handling*.

B. **Construction:**

1) **Construction**: Water mains and fittings shall be installed with approved tools in accordance with the requirements of ANSI/AWWA Standard Specification C600, *Installation of Ductile Iron Water Mains and Their Appurtenances*, which is herein made part of the specification by reference.

Construct piping to accurate lines and grades avoiding localized high points and support as required on drawings or described in specifications. When temporary supports are used, ensure that sufficient rigidity is provided to prevent shifting or distortion of pipe.

Pipe shall be laid with bell ends upgrade and facing the direction of laying.

Due care shall be taken in the storing and handling of pipes, fittings and valves to avoid contamination with the ground and prevent foreign matter from entering pipe and fittings. String out no more pipe than can be installed in a day. Gaskets shall be lubricated as per manufacturer's recommendations.

Pipe, fittings, and valves shall be carefully handled and lowered into the trench. Under no circumstances shall any pipe or fitting be dumped or rolled into the trench, or be allowed to drop against the pipe or fitting already in the trench. Great care shall be taken to prevent the pipe lining and coating from being damaged, and the Contractor shall not install any damaged pipe. The contractor shall be responsible for removal and disposal of damaged pipe.

Prior to being lowered in to the trench, all pipes shall be carefully inspected to see that each pipe is clean. If necessary, pipes shall be fitted together to ensure sufficient opening for the gasket or joint compound and smooth inside flow line.

Special care shall be taken to ensure that the pipe is well bedded on a solid foundation, and any defects due to settlement shall be made good by the Contractor at his own expense. Bell holes shall be dug sufficiently large to ensure the making of proper joints. Special precautions shall be exercised to prevent any pipe barrel or bell from resting on rock. A minimum of 6 inches is required between rock and the bottom of pipe (see **Standard Detail 511.03** and paragraph 3.2.5 F – *Cushioning Pipe in Rock*, of 02275 – *Trenching, Backfilling, and Compaction of Utilities*). If the bed formed in the bottom of the trench is too low, the pipe shall be removed, clean stone placed in the bottom, and a new bed prepared for the pipe. In no case shall the pipe be brought to grade by blocking under the barrel of the pipe. A uniform support shall be provided for the entire length of the pipe.

Whenever a pipe requires cutting, to fit in the line or to bring it to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe, and not otherwise damage the pipe or liner. When the cut end is to be assembled in a *Fastite* bell, an adequately smooth (without sharp edges) bevel should be ground or filed on the cut edge to prevent damage to or dislodgement of the gasket during assembly. Generous bevels are

advantageous in the assembly of field prepared ends. The approved methods of cutting pipe are: rotary type, abrasive wheel, and snapcutter on DIP. No welding, flame cutting or flame tapping will be allowed.

The Contractor shall be required at the end of the day's work to keep the end of the line, under construction, plugged to prevent foreign matter from entering pipe and fittings. A watertight plug shall be placed in the bell of the last joint of pipe laid. The pipe shall not be used as a means of draining ground water from the area.

Maximum horizontal deflections for ductile iron pipe shall meet AWWA C600, latest revision or pipe manufacturer's recommendation.

Allowable Joint Deflection of Slip Joint Pipe

Size (inches)	Nominal Laying Length (feet)	Maximum Allowable Deflection	
		Offset per Length (inches)	Deflection Angle (degrees/radius, ft)
6	18	19	5°/205
8	18	19	5°/205
12	18	19	5°/205
16	18	15	4°/26
20	18	11	3°/340
24	18	11	3°/340

Ref: AWWA C600.

a) **Minimum Pipe Bury**: Mains shall be installed to the depth that provides 36 inches of cover below finished grade for mains 6 inches and smaller. Mains 8 inches and larger shall be provided with a minimum of 42 inches of cover below finished grade. See also **Standard Detail 511.01**. In the event site conditions prevent adherence to minimum cover requirements, approval of an alternate design by the Engineering Director is required. See Table 02275.1 of *02275 – Trenching, Backfilling, and Compaction of Utilities*.

b) **Installing Mechanical Joint Pipe**

i. Gaskets shall not be exposed to oil, grease, ozone, extensive heat, sunlight, or other elements that would degrade the gasket. Store gasket in a cool dark place until installation in accordance with manufacturer's recommendations.

ii. Clean socket and plain end thoroughly, removing mud, oil, gravel, or any other foreign matter. Gaskets shall be lubricated. Paint the bell and the spigot with soap solution (half cup granulated soap dissolved in 1 gallon of water). Slip ductile iron gland on spigot end with the lip extension of the gland toward the end of the pipe. Paint rubber gasket with or dip into the soap solution and place on the spigot end with thick edge toward the gland.

iii. Push the spigot end forward to seat in the bell. Then, press the gasket into the bell so that it is located evenly around the joint. Move the gland

into position, insert bolts, and screw nuts up finger tight. Then tight all nuts to torque listed below (excerpted from Table 2 of AWWA C600):

Bolt Size (Inches)	Torque (Ft. – Lbs.)
5/8	45-60
3/4	75-90
1	100-120
1 1/4	120-150

Tighten nuts on alternate side of the gland until pressure on the gland is equally distributed.

iv. Permissible deflection in mechanical joint pipe shall not be greater than listed in Table 4 of AWWA C600.

Allowable Joint Deflection Mechanical Joint Pipe			
Size (inches)	Nominal Laying Length (feet)	Maximum Allowable Deflection	
		Offset per Length (inches)	Deflection Angle (degrees/radius, ft)
6	18	27	7°-07'/145
8	18	20	5°-21'/195
12	18	20	5°-21'/195
16	18	13.5	3°-35'/285
20	18	11	3°-00'/340
24	18	9	2°-23'/450

Ref: AWWA C600

c) **Installing Push on pipe**

i. Gaskets shall not be exposed to oil, grease, ozone, extensive heat, sunlight, or other elements that would degrade the gasket. Store gasket in a cool dark place until installation in accordance with manufacturer's recommendations.

ii. Clean the socket and 8 inches of the outside of the plain end thoroughly, removing mud, gravel, or any other matter that might cause the front of the gasket to protrude into the path of the entering spigot. Flex rubber gasket and apply lubricant supplied with the pipe to the plain end and to the inside surface of the gasket before assembly. Start the spigot end of the pipe in to the socket with care. The circumferential stripe on the plain end provides a visual indication for checking the proper insertion of the joint. Insert gasket fully in the gasket recess of the socket, large end of the gasket entering first. For assurance of proper gasket positioning, a thin automotive, blade-type feeler gauge can be used for quick and easy probing to confirm a properly installed gasket position around the joint. Then complete the joint by forcing the plain end to the bottom of the socket with a forked tool or jack-type device.

2) **Cutting Pavement/Driveways**

Where the water line is in an existing paved area, the edges of the pavement for the water line shall be cut in a straight line, parallel to the pipe on each side. Perform cutting operations prior to installation of water line to avoid excessive removal of asphalt. Care shall also be taken during installation of pipe to avoid damage to adjoining paved surfaces. Refer to the applicable Town or NCDOT standard pavement repair details pavement width and patching requirements. Driveway crossings shall be completed within 48 hours after the initial cutting of the pavement.

3) **Protection of Pavement**

Whenever the water line is to be placed in or near a paved street, the contractor shall provide pads or take necessary precautions to protect the pavement from damage by construction equipment. Pavement damage by cleats or tracked equipment, or by any other means, shall be repaired by the contractor.

C. **Connections to Existing Mains**

The Contractor shall furnish all materials for connection to existing water mains. Town shall be the sole operator of all valves and fire hydrants.

In making connections to the existing distribution system, valves shall be set as shown on the plans.

See paragraph 1.12, Coordination for limitations on valve operation and system shut down.

Before shutting off any main, residents are to be notified in writing at least 48 hours in advance of cut off. . Town shall be notified at least 1 week in advance of request for operation of valves and making either a wet tap or cut-in.

If the connection to the existing mains requires a wet tap, such tap shall be done by a firm experienced and equipped to do this type of work. All materials and labor shall be provided by the contractor to include, but not necessary limited to the sleeve, valve, tapping machine, accessories, installation, and testing of such materials to complete the work. Town shall have the right to approve the firm or crew performing the work.

Work shall be scheduled at least one week in advance through the Town's Engineering Technician. A Town Representative shall be present during the operation. After installation of the tapping sleeve and valve and prior to performing the tap, the assembly shall be pneumatically tested at a pressure equal to the test pressure of the new line installed. Such pressure shall be maintained with no loss for a minimum time of 15 minutes.

D. **Removal of Asbestos Cement Pipe**

The contractor is hereby advised that some of the pipe within the Town distribution system may contain asbestos. Removal, handling, and disposal of asbestos cement pipe shall be performed in accordance with applicable EPA and OSHA regulations and applicable Federal, State and local regulations. Documentation and paperwork as well as a chain of custody are to be provided to Town.

E. **Utility Protection**

Take necessary precautions to protect existing utilities from damage due to any construction activity. The contractor shall locate existing utilities, culverts, and structures (above or below ground), before any excavation starts and coordinate work with utility companies. Protect, maintain in service, and prevent damage to utilities not designated to be removed. Omission from or inclusion of located utility items on plans does not constitute non-existent or definite location. Secure and examine local utility surveyor records for available location data including building service lines. Contact underground damage protection services by contacting **NC One Call Center** at least 48 hours before you dig.



The contractor shall protect, maintain in service, and prevent damage to utilities not designated to be removed. When utilities are encountered and are not shown on drawings or when locations differ from those shown on drawings, notify the Project Engineer for instruction before proceeding. In the event that a gas line, water line, power cable or conduit, or telephone cable or conduit is broken or damaged, the contractor shall give immediate notice to the proper authorities and shall be responsible for any damage to persons or property caused by such breaks. If a service pipe supplying water or gas to an adjoining house is broken, the contractor shall repair same at once. Town may, at the contractor's expense, repair any such service without prior notice to Contractor.

Should it become necessary to move the position of any underground structure, the contractor may be required to do such work.

The Contractor shall be responsible for protecting all existing utilities that could be damaged by excavation near the proposed line. Trench boxes may be necessary to prevent sloughing, etc., as well as to protect workmen, the motoring public, and the pavement. Failure to use a box, which subsequently results in damage to an existing line or other public improvements, shall be cause for liability against the Contractor for the repair costs.

F. **Surface or Ground Water in Trenches/Pipe**

When ground water is encountered, the contractor shall pump, or otherwise remove any water that accumulates in the trenches and shall perform all work necessary to keep the trenches clear from water while pipe is being laid. No pipe shall be constructed in water and water shall not be allowed to drain through the pipe. At the end of the day, the open end of the pipe shall be kept closed by placing a watertight fitting plug into the bell end to prevent washing of any foreign matter into the line. All water removed from the trench shall be conveyed in a proper manner to a suitable point of discharge and shall comply with the applicable erosion and sedimentation laws. See also paragraph 3.1.6, *Dewatering* of 02275 *– Trenching, Backfilling, and Compaction of Utilities*.

G. **Abandoning of an Existing Water Services/Lines**

Removal of Lines from Service: The Contractor shall remove abandoned lines from active service upon completion of replacement line, and after transfer of service to a replacement line. Under circumstances where the line to be abandoned is 2 inches or less in diameter and threaded galvanized pipe is

screwed into a mechanical joint plug, the line may be deleted from active service through removal of the galvanized line from the mechanical joint plug and replaced with a threaded brass plug. Under circumstances where the line to be abandoned is connected to a lead joint cross or tee, the section of line being intercepted which contains the lead joint cross or tee shall be replaced with mechanical joint fittings or straight pipe using mechanical joint sleeves. All plastic fittings shall be replaced with ductile iron or other fittings approved by the Engineering Director.

Services: When abandoning services 2-inch or less in diameter, the line shall be cut at the corporation stop/gate valve on the main or as close to the main as possible and a minimum one-foot segment of the line removed.

Mains: When an existing water main is replaced with a new water main, abandonment of the existing line is required once it is no longer in service. All mains are to be abandoned at source, valve removed, and the "tee" or tapping sleeve plugged with a mechanical plug. Location of abandonment shall be approved by a Town representative.

3.1.2 STEEL ENCASEMENT PIPE – DRY BORING & JACKING OR OPEN CUT

A. **General**: Where required, steel encasement pipe shall meet the length as shown on the plans and the thickness and diameter as shown on **Standard Detail C07.01**. Boring across roads and railways shall be performed by dry boring and jacking a steel encasement pipe under the pavement or rail. The encasement shall be located in an area that is relatively free from material such as rock and stone that may hamper the boring operation.

Construction shall be executed in such a manner as to prevent settlement of the ground surface above the pipeline.

All operations of the contractor shall be subordinate to the free and unobstructed use of the right of way of the passage of traffic without delay or danger to life, equipment, or property. Installation shall be in accordance with of the *NCDOT Standard Specifications for Roads and Bridges, latest revision* or AREA, as applicable.

The pipe shall be beveled and prepared for field welding at the circumferential joints. Joining of steel casing pipe shall meet the requirements of AWWA C206, AWWA *Standard for Field Welding of Steel Water Pipe*. Field welded joints shall be performed by AWS D.1.1 certified welders and shall be full penetration single vee groove, butt type welds around the entire circumference of the pipe. The pipe shall be in at least 18-foot lengths. Casing shall be installed either by dry boring and jacking or open cut, as indicated on the drawings.

Encasement ends shall be enclosed as shown on **Standard Detail C07.01**. The steel encasement pipe shall be of leak proof construction. All exposed metal is to be coated with epoxy or asphaltic material.

All carrier piping shall be mechanical joint ductile iron pipe with restrained joints supported by spiders.

Manufactured Spiders/Skids: The spiders necessary to support the carrier pipe inside of the steel encasement pipe shall be in accordance with *paragraph 2.1.5 B, Spiders/Skids for Encasement Pipes*. Unless otherwise shown on the drawings,

one spider shall be placed at each bell end and one at each spigot end (2 spiders per joint) of the carrier pipe as well as at each end of the encasement pipe (see **Standard Detail C07.01** for location of spiders).

3.1.3 TUNNELING METHOD

A. **General**:

1) The contractor shall submit shop drawings to Engineering Director for approval prior to construction. All liner plates and ribs used in the tunnel shall be of one type. All material removed shall be disposed of off the site by the Contractor.

2) All operations of the Contractor shall be subordinate to the free and unobstructed use of the rights of way for passage of traffic without delay or danger to life, equipment, or property. The Contractor shall provide all necessary bracing, bulkheads, and shields to ensure complete safety to all traffic at all times. The Contractor shall provide all traffic control devices as necessary and as shown on the approved traffic control plan at no additional cost.

B. **Tunneling (Boring Method):**

1) Commence boring operation from a pit, with the bottom excavated to grade, and sheeted or shored if necessary. Boring through soil shall have a steel pipe jacked in place as a casing pipe. Boring through rock shall be oversized to allow installation of carrier pipe but no casing pipe shall be required unless liner plate is necessary for safety reasons.

2) Smoothly pave the bottom of the tunnel with concrete. Pull the carrier pipe in place a joint at a time. Securely block each section in place.

C. **Tunneling (Hand Mining)**

1) Commence tunneling operation from a pit, with the bottom excavated to plan grade, and sheeted or shored if necessary.

2) All blasting shall conform to requirements for blasting in *02275 – Trenching, Backfilling and Compaction of Utilities*.

3) Install the steel liner plates immediately after the excavated material has been removed, and remove the material not more than 24 inches ahead of the installed liner plates.

4) Grout all voids between the soil and tunnel liner plates. The maximum grouting pressure shall be 30-psi. Start grouting at the bottom of the tunnel liner plates and proceed upward progressively and simultaneously on both sides of the tunnel. Install liner plates no more than 6 feet ahead of grout section. Prohibit traffic over ungrouted sections of tunnel unless this section is in solid rock. Thoroughly dry-mix grout ingredients before adding water. After adding water, mix the batch for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. Placing shall be quick and continuous. Placement shall be under pressure with a grout pump. The period between installation of the tunnel liner plate and the placing of grout shall not exceed 7 hours, without

the approval of Engineering Director. Upon completion of grouting, fill grout plugs with provided grout hole plugs.

A pump shall be provided for placing the grout which shall be capable of exerting sufficient pressure to assure the filling of all voids between the liner plate and the undisturbed ground. Minimum acceptable pressure to fill voids will be 5 psi. The maximum grouting pressure shall be 30-psi.
Pumping of grout shall be done:

i. At the completion of the installation of approximately each 6-foot of liner plate,
ii. At more frequent intervals than 6-foot if conditions indicate the necessity, and
iii. At the end of a work shift or for stopping of work for any reason.

5) Smoothly pave the bottom of the tunnel with concrete: After installation of the tunnel liner plates, the contractor shall pour concrete pavement on the bottom quadrant (invert) of the tunnel, the surface of the pavement being parallel to the liner plate, with screed rails embedded in it, on line and grade for the installation of pipe in the tunnel.

6) The periphery of the tunnel shall be trimmed smooth to fit the outside of the steel liner plate as nearly as is practical, so that the void outside the plates is a minimum.

7) After installation of the casing pipe or the tunnel liner, pull the carrier pipe in place a joint at a time. Securely block each section in place. Each joint of the carrier pipe shall be supported at two points by steel saddles or by steel spiders, strapped to the carrier pipe with steel straps. The carrier pipe shall be blocked, in place to the prevent flotation.

8) Close tunnel liner ends to protect against entrance or foreign matter. The open ends of the casing pipe or tunnel shall be closed off by an 8-inch grout or masonry block wall prior to backfilling. A steel drain line to a 1 cubic yard French drain shall be provided.

9) If installation is under railway tracks, all permits shall be obtained and Railway Company shall be notified prior to such installation. The same shall apply to contacting the applicable Municipality or NCDOT if installation is under a roadway.

D. See also **PART 2 – PRODUCTS**, Section 2.1.6, "*Tunnel Liners and Appurtenances."*

3.1.4 HORIZONTAL DIRECTIONAL DRILLING OF HDPE WATER PIPE

A. HDPE pipe shall be installed by Horizontal Directional Drilling (HDD) using a surface mounted rig, first to drill a guided hole along a bore path consisting of a shallow arc and then to pull a string of pipe into the hole. Pull back is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe diameter. Drilling fluids are injected into the bore hole to stabilize the hole and lubricate the pipe and drill-string. Tracking equipment is used to guide and direct the drilling.

1) Mechanical Restraint

When Polyethylene pipe is pressurized, it expands slightly and shortens slightly. Shortening may be enough to disjoin unrestrained mechanical joints that are in line with PE pipe.

Restraint - Thrust Blocks: HDPE systems do not typically require thrust restraint; however, when it is necessary to prevent disjoining pipe, the disjoining can be prevented by installing line anchors or by a combination of both external joint restraints and line anchors at:

1. Directional transitions within pressurized pipeline systems,
2. Unrestrained joints (e.g., bell and spigot),
3. When HDPE connects to mechanical joint pipe,
4. When shown on the project drawings, or
5. When directed by the Engineering Director.

PE wall anchors, placed within a concrete thrust anchor block, shall be either a butt fused wall anchor or an electrofusion flex restraint anchor.

Note: Poisson Effect pipe shortening must be taken into account whenever the pipe is pressurized, both during the pressure testing, and when it is placed in service. Because pressures are usually higher during pressure testing (up to 150% of the system pressure rating), pipe expansion and Poisson Effect pipe shortening may be slightly greater during pressure testing. Before pressure testing, all mechanical joint restraints must be completely installed and secured per manufacturer's instructions. Concrete in-line anchors and thrust blocking (if used) must be fully cured (minimum of 21 days for 3,000 psi or 7 days for 4,500 psi concrete) and properly backfilled before testing. Restraint is not required at PE to PE butt fusion joints. Restraint is not required at bolted flanged joints.

Mechanical Couplings: Stainless steel internal stiffeners shall be used on all couplings to increase the seal. All couplings shall have restraint devices per the manufacturer's recommendation and installed per the Manufacturer's direction.

See the **Pre-Approved Product List** for approved HDPE pipe manufacturers and cast coupling manufacturers and model numbers compatible with HDPE.

B. **Installation and Testing**

The Manufacturer shall supply an Installation Manual to Engineering Director, which outlines guidelines for handling, joining, installing, embedding, and testing of the Polyethylene Pipeline. These guidelines shall be used as reference material by Engineering Director in his determination of the required procedures.

Joints between plain ends of HDPE pipe shall be made by butt fusion when possible. The pipe manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the fusion machine manufacturer. The wall thicknesses of the adjoining pipes and fittings shall have the same DR at the point of fusion.

When saddle connections are fusion welded, the Manufacturer's recommended saddle fusion procedures shall be used.

If mechanical fittings (which are designed for, or tested and found acceptable for use with HDPE pipe) are utilized for transitions between pipe materials, repairs, joining pipe sections, saddle connections, or at other locations; the recommendation of the Mechanical Fitting manufacturer must be followed. These procedures may differ from other pipe materials.

On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, and then fusion test straps shall be cut out. The test strap shall be 12 inches long or 30 times the wall thickness in length (minimum) and 1 inch or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trail fusion shall be made, cooled completely, and tested. Butt fusion of pipe to be installed shall not commence until a trail fusion has passed the bent strap test.

Socket and Straddle fusions shall be tested by a bent strap test as described by the Pipe manufacturer. The pipe manufacturer shall provide visual guidelines for inspecting the butt, saddle, and socket fusion joints.

Pressure testing shall be conducted in accordance with manufacturer's recommended procedure. Pressure testing shall use water as the test media. Pneumatic testing is prohibited.

C. **Shop Drawings**

Contractor shall submit shop drawings and details on the proposed HDPE pipe, fittings, bore methods, etc., for review and approval of Engineering Director before ordering material or beginning installation of the HDPE. Contractor shall also submit to Engineering Director proposed subcontractor's name as well as references on which he/she plans to use on this project. All subcontractors/installers must be approved by Engineering Director.

3.1.5 HORIZONTAL DIRECTIONAL DRILLING OF PVC C900 FUSIBLE WATER PIPE

C900 fusible PVC pipe (6- through 12-inch pipe) shall only be used with written approval from the Engineering Director.

A. PVC C900 pipe shall be installed by Horizontal Directional Drilling (HDD) using a surface mounted rig; first to drill a guided hole along a bore path consisting of a shallow arc and then, to pull a string of pipe into the hole. Pull back is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe diameter. Drilling fluids are injected into the borehole to stabilize the hole and lubricate the pipe and drill-string. Tracking equipment is used to guide and direct the drilling.

B. **Installation and Testing**

The Manufacturer shall supply an Installation Manual to the Engineering Director, which outlines guidelines for handling, joining, installing, embedding, and testing

of the Fusible C900 Pipeline. These guidelines shall be used as reference material by the Engineering Director in his determination of the required procedures.

Joints between plain ends of Fusible C900 pipe shall be made by butt fusion when possible. The pipe manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the fusion machine manufacturer. The wall thicknesses of the adjoining pipes and fittings shall have the same DR at the point of fusion.

When saddle connections are fusion welded, the Manufacturer's recommended saddle fusion procedures shall be used.

If mechanical fittings are utilized for transitions between pipe materials, repairs, joining pipe sections, saddle connections, or at other locations; the recommendation of the Mechanical Fitting manufacturer must be followed.

Pressure testing shall be conducted in accordance with Town of Clayton specifications.

C. **Shop Drawings**

Contractor shall submit shop drawings and details on the proposed Fusible C900 pipe, fittings, bore methods, etc., for review and approval of the Engineering Director before ordering material or beginning installation of the Fusible C900 pipe. Contractor shall also submit to the Engineering Director proposed Subcontractor's name as well as references on which he/she plans to use on this project. All subcontractors/installers must be approved by the Engineering Director.

3.1.6 PVC PIPE

PVC pipe shall only be used with written approval from Engineering Director.

3.2 VALVES AND FIRE HYDRANTS

A. **Valve Applications**

1) **Valves – vault/above ground applications**:

a.	Ball Valves 2-inch and smaller:	¼-Turn Stainless Steel Ball Valve
b.	Gate valves 2-inch and larger:	NRS, OS & Y
c.	Relief Valves:	Air/Vacuum Release Valves
d.	Water-Regulating Valves:	Pressure-regulating valves Flow-regulating valves
e.	Detection of unauthorized water:	Detector Check Valves
f.	Backflow prevention:	Reduced Pressure Zone Backflow Preventers – USC approved Double Check Valve Assemblies – UL/FM rated

2) **Valves – below ground applications**: Non-rising stem.

3.2.1 GATE VALVES

A. **Setting of valves and valve boxes**: Valves shall be installed with stems in a vertical plane through the pipe axis and perpendicular to the pipe axis. The contractor shall clean the valves before installation and check for satisfactory operation. Valve nut extensions shall not be installed unless approved by Engineering Director.

Nipples for 4-inch through 12-inch valves shall be cut so that the valves are installed no more than 4 feet from the fitting (centerline to centerline). 2-inch valves shall be installed with a 4-inch long brass nipple. See sheet 3 of **Standard Detail 519.03** for an example.

All valves adjacent to tees or bends shall be tied to the fitting with a wedge action restrainer joint/gland (see **Standard Detail 512.02** and the Pre-Approved Product List for an approved list of MJ Restraint (Restrainer) Gland manufacturers and model numbers). The Engineering Director may require ASTM A307 threaded stainless steel tie rods in addition to the mechanical restrain system. See **Standard Detail 512.06** for number and diameter of tie rods).

Valves must match line size.

B. All underground valves without gearing or operators shall be equipped with a 2-piece valve box with lid (see **Standard Detail 513.01**). Valve boxes shall be set on concrete brick placed beneath the bottom outstanding flange of the valve box. Place a minimum of 1 inch of earth cushion beneath the concrete brick and the valve and the valve box set in alignment with the valve stem centered on the valve nut, set in a manner to prevent transmitting shock or stress to the valve. Valve box cover must be set flush with the finished ground surface or pavement. The contractor shall be responsible for keeping valve boxes clean and free of any foreign matter until acceptance of the project.

C. **Valve Box Adjustment**: The Contractor shall adjust valve boxes to final grade at the time designated by the Engineering Director. The Contractor shall terminate the top of the valve boxes in asphalt or concrete pavement or, in unpaved areas (e.g., fields and easements), place a precast concrete donut above the valve box. See **Standard Detail 513.03.** Valve boxes in easements are to be provided with a valve box marker post. No extra payment will be made for these items.

D. **Valve Box Removal:** When shown on the drawings or directed by the Engineering Director, the Contractor shall remove existing valve box(es), place select fill, stone or other material and repair pavement. Salvaged valve box(es) are to be delivered to the Town of Clayton Operations Center.

3.2.2 VALVES 16 INCHES AND LARGER (GATE OR BUTTERFLY VALVES)

Valves with gearing or operators shall be installed in a manhole. The manhole shall be constructed/set in such a way as to prevent transmitting any load or shock to the valve. It is also to be set in such a way that the packing, operator, and other parts of valve are readily accessible for minor repairs. When set in a manhole, the valve is to be flanged joint and set with a flanged coupling adapter on one end to

permit valve removal for maintenance. Manholes shall be constructed in accordance with the **Standard Detail 513.09**. Manhole opening shall be positioned over the operating nut. Valves are to be coated. Either a resilient seat gate valve or a butterfly valve may be used.

3.2.3 STAINLESS STEEL TAPPING SLEEVES AND VALVES

Stainless steel tapping sleeves and flange x MJ gate valves shall be installed in accordance with the manufacturer's recommendations at locations shown on the plans. The Contractor shall make connection to existing water mains in the manner shown on the plans or otherwise in a manner which is satisfactory to the Town. With prior approval, when taps are made on asbestos cement pipe, the Contractor shall excavate at the location of the tap and measure the diameter of the pipe prior to selecting a tapping sleeve to ensure the sleeve will fit the pipe (this information shall be provided to the Town of Clayton on the as-built drawings). See **Standard Detail 513.02**. Contactor is responsible for traffic control, excavating, dewatering, and safe access in the trench at the time of tap. The Contractor is to provide taping sleeve and valve.

See **Pre-Approved Product List** for approved stainless steel tapping sleeve manufacturers and model numbers.

3.2.4 AIR RELEASE VALVES

AWWA C512 air release valves are to be used to bleed air during filling of a water line and to automatically vent air that collects in the water lines. Pressure air release valves shall be located as shown on the drawings. The valve shall be housed in a minimum 5-foot diameter precast concrete eccentric manhole and shall be installed in accordance with **Standard Details 516.01** (Water Main Air Release Manhole). All pipe and fittings are to be brass including the plumbing gate valve. ¼ turn ball valve to be stainless steel. Air release valve locations shall be as shown on the plans and as otherwise directed by Engineering Director.

See **Pre-Approved Product List** for approved air release valve manufacturers and model numbers.

3.2.5 FIRE HYDRANTS

A. **Construction**: Fire hydrants shall be installed where shown upon the plans or as directed by the Fire Marshall and/or Engineering Director. Hydrants shall be set upon a concrete block in such manner as to preclude the possibility of settlement of hydrants. Place loose #57 stone around the hydrant elbow. Hydrants to be provided with a Romac Alpha Restrained Joint Base and with an auxiliary straight pattern 5-inch Storz nozzle Fire Department Connection (do not paint Storz nozzle). See **Standard Details 514.04** and **514.05** and paragraph 2.2.8 for fire hydrant specs.

Hydrants are to be located at right of way line and set to the height prescribed by **Standard Details 514.04** and **514.05** with the pumper nozzle facing or pointing to the street or fire access lane. A resilient seat gate valve shall be installed with an anchor tee. Care shall be taken to keep concrete away from bolts and weep holes. Hydrants must be set with the stem vertical/plumb and the flange above grade. The Contractor is responsible for determining barrel length and ordering to meet conditions. Where adjustments in height are needed, provide extension kits at no

additional cost. However, only one 24-inch riser extension is allowed per hydrant. Where hydrants are set behind guardrails, the pumper nozzle shall be set with its centerline a minimum of 12 inches and a maximum of 18 inches above the top of the guardrail.

A Town representative must inspect fire hydrants prior to backfilling.

B. Hydrants are to be attached to the valve with a restrain flange joint system (preferred over use of 3/4" diameter stainless steel all-thread rods. Where hydrant branches exceed 20 feet, place a thrust block behind the first full joint of pipe on the hydrant branch between the hydrant and the leg valve. For rodded connections, where test pressures are expected to exceed 200 psi, rod with a minimum of 4 rods.

Threaded tie rods shall be type 316 stainless steel thread rods (all thread) in accordance with paragraph 2.3.13. No duck lugs will be allowed. Restraint flange joint restraint systems are preferred over tie rods.

Operation and Painting: Hydrants, upon installation and prior to acceptance of the project, shall be painted and greased, the cap is to be sprayed (non-petroleum based) after installation, and individually operated in front of an Town representative to verify the hydrant is wet. Paint hydrant barrel & bonnet with Sherwin Williams industrial enamel or equal Federal Safety Red paint. Surfaces to be painted shall be free of oil, dirt and rust. l Do not remove chains.

C. **Hydrant Bagging – Not Permitted**:

D. **Valving of Main**: A leg valve is required on all hydrant legs. Install hydrant valve on anchor tee. When valve is placed outside the pavement, provide a precast concrete donut in accordance with **Standard Detail 513.03**.

E. Fire hydrants are to be pressure tested with the main.

3.2.6 BACKFLOW PREVENTERS

See Town of Clayton Cross-Connection/Backflow Protection Ordinance (Chapter 53) latest adoption as applicable.

3.3 MISCELLANEOUS APPURTENANCES

3.3.1 SERVICES

A. **General**: All fees must be paid and work scheduled with the Town before the tap can be made. All materials must be on-site, trenches open, and shoring and traffic control devices in-place before the tap is made. Contractor may be required to provide traffic control plan that meets all MUTCD regulations.

1) **Allowable Tapping methods:**

a. ¾-inch and 1-inch taps are to be made by all bronze double strap tapping saddle. For saddle models to fit various types of pipe, see *Tapping Service Saddle* in the Water Products section of the **Pre-Approved Product List** and the table *"Fitting by Type of Pipe."* See also **Standard Detail 513.04**.

b. 2-inch taps are to be made by all bronze double strap tapping saddle. For saddle models to fit various types of pipe, see *Tapping Service Saddle* in the Water Products section of the **Pre-Approved Product List** and the table *"Fitting by Type of Pipe."* See also **Standard Detail 519.03**.
c. Taps 4-inches and larger are to be made using an all stainless steel tapping sleeve or a fitting. Iron body sleeves are not permitted. See **Standard Detail 513.02**
d. Service taps shall also be subject to the requirements of AWWA C600, *Installation of Ductile Iron Water Mains and their Appurtenances, latest revision.*

Service Connections on "In-Service" water mains.	
Size Connection	**Responsibility**
¾-inch through 1-inch services	Contractor makes tap and runs service line and sets meter box and setter (as applicable). Town sets meter.
2-inch and larger services	Contractor makes tap, runs service line, sets meter box or vault, and furnishes all material. Contractor sets meter.

2) **Tap Location – 3/4-inch through 2-inch Copper Service Lines**: Taps 2-inches and smaller shall be made no closer than 24 inches apart and no closer than 18 inches from a pipe joint up to 16" diameter (see **Standard Detail 513.04**).

Water service pipe shall be one continuous run, from main to meter setter, of copper pipe with no joints or couplings in between. Service lines shall run perpendicular to the main in a straight line between the water main to the meter box/property served. No sharp bend of the service line will be permitted. Service lines shall not be located beneath driveways.

Firm bedding with at least 18 inches of cover shall be provided from the corporation to near the meter setter. Copper service lines shall have a minimum of 30 inches of cover from the water line to the top of the back of curb or centerline of the drainage ditch.

Backfill shall be free of rocks or large objects that could crimp or damage the line. Service line trenches in traffic areas shall be tamped to achieve 95% Standard Proctor Density. In landscaped areas, the surface shall be left smooth and uniform with the adjacent surface.

B. **¾-inch and 1-inch taps**: All 3/4 –inch and 1-inch taps into water mains shall be made using an all-bronze double strap tapping saddle, both with an all bronze corporation stop. Corporation stop for saddles shall have AWWA Standard CC tapered threads. Taps shall be made at a 45° angle above the horizontal on the upper half of the pipe. A bend in the service line shall be provided in the service line as it leaves the corporation stop to provide for expansion/contraction and flexibility. A double strap shall be used on both PVC and AC pipe. Multiple taps in the same side of the pipe shall be staggered vertically a minimum of 1-inch (see **Standard Detail 513.04**).

C. **2-inch taps**: 2-inch taps shall be made using an all bronze double strap saddle. Water service pipe for 2-inch connections shall be type K hard copper with

compression fittings. For short distances between the main and the meter, threaded brass pipe may be used. Taps shall be made at a 90° angle to the pipe. See sheet 2 of **Standard Detail 519.03** and paragraph 2.3.12 B.

D. **Large taps**: Taps 4-inch and larger shall be made using all stainless steel tapping sleeves and tapping valves for existing lines or a tee and valve on new lines. A Town representative must inspect all service connections prior to backfilling. Only one 4-inch or larger tap shall be made per joint of pipe on AC and/or pit cast (gray iron) pipe. The outside diameter of the pipe must be measured at the location of the tap to determine the appropriately sized tapping saddle. See Standard **Detail 513.02**.

E. **Meter Boxes and Setters – Installation**:

1) **Small Meter Boxes**: Meter boxes for 5/8-inch and 1-inch meters shall be installed at and within right-of-way line. Meter boxes shall be set on a concrete brick with one brick set vertical at each end to cover the elongated slot. The box and brick shall be set on undisturbed grade. All meter boxes shall be set so that there is 7 inches of clearance between the top of the box and the centerline of the meter setter. The meter setter shall be straight, level and centered in the box. Meter boxes shall be set to avoid inflow of surface water into the box. See **Standard Detail 519.01**.

Meter yoke for ¾"- and 1-inch meters shall be provided with a 36-inch long copper tailpiece extending horizontally out the back of the meter box, or beyond the edge of the sidewalk when meter box is set in sidewalk, the end turned up with the end either plugged or crimped. A steel sediment fence channel post is to be set beside the turned up tail section for protection. See **Standard Detail 519.01**.

2) **2-inch Meter Boxes**: Meter boxes for 2-inch meters shall be placed with a concrete brick on each end to cover elongated slot. Concrete bricks shall be placed underneath meter box for support. The box and brick shall be set on NCDOT #57 or #67 stone. Meter boxes shall be set so that there is 12 inches of clearance between the top of the box and the cut-off nut on the meter setter. The meter setter shall be straight, level and centered in the box. Meter boxes shall be set to avoid inflow of surface water. See **Standard Detail 519.03**.

Meter setters for 2-inch meters shall be provided with a section of copper pipe buried 24 inches and extending 2 feet horizontally out the back of the meter box, or 2 feet beyond the edge of the sidewalk when meter box is set in sidewalk, and the end either plugged or crimped. Setters are to be perpendicular to meter and vertical. Meter shall be set by contractor at time the tap is installed for proper spacing. Stabilizer bars are required to be provided on setter.

F. **Large Meter Vaults**: Meter vaults for 3-inch and larger meters shall be placed level on a 12-inch minimum bed of #57 stone that has been thoroughly and firmly consolidated. Meters and fittings shall be supported by pipe stands. Vault doors shall be centered over the meter and otherwise located as shown on **Standard Details 519.04** and **519.05**. Drains to daylight are requred in meter vaults. In the event positive grade cannot be achi8eved by a floor drain/pipe to daylight, an above-ground meter may be used similar to the vault shown in **Standard Detail 519.08**.

G. **Grounding to Water Services**: Grounding shall not be allowed to be connected to meter boxes or vaults. As a minimum, place meter boxes/vaults no closer than 10 feet from a building. If unavoidable, place a grounding jumper around meter box/vault.

H. **Abandoning Water Services**: see paragraph 3.1.1 G *Abandoning of Existing Water Services/Mains*.

I. **Water Service Replacement:** All existing water services along the water main are to be reconnected to the new water main. Contractor shall install a new corporation stop, service line between proposed water line and existing service at the water meter box, and a new meter setter and new water meter, if necessary. All taps in PVC pipe shall be accomplished through the use of shell type hole cutter which will retain the coupon or plugs. Existing meter setters will be the property of the Town and be delivered to the Operations Center. *Water services shall be classified for payment as to their location in relation to the new water main and the centerline of the street*.

Relocation of water meters to the existing right of way, including all necessary materials, labor, and surface restoration shall be considered incidental to the water service replacement and be included in the unit price bid for the item.

J. **Testing**: All taps and services shall be pressure tested with the main.

3.3.2 RESTRAINTS/CONCRETE THRUST BLOCKING

A. **Thrust Blocking**: Thrust Blocking must be installed at all fittings and changes in direction of the pipe line. Thrust blocks shall be constructed from minimum 3000 psi concrete (at 28 days) and poured against an undisturbed earth trench wall. Concrete thrust blocking shall be constructed in accordance with **Standard Detail 512.01**. Sakrete is not permitted. Concrete anchors may be unformed but minimum dimensions must be maintained. To allow accessibility for future repairs, all fittings and pipe shall be wrapped in minimum 6 mil polyethylene plastic prior to installation of concrete to ensure that bolts and nuts are free of concrete and debris. When soft, mucky, unsuitable, or unstable soils are encountered, thrust shall be resisted by running tie rods to solid foundations by removing the soft materials and replacing it with ballast of sufficient size and weight to resist thrust.

Vertical upward thrust at fittings or vertically deflected joints shall be resisted with thrust collars of adequate size and weight to resist thrust. See **Standard Detail 512.04**.

Pipe manufacturer's installation manuals shall be followed for the anchoring of valves and fittings in difficult locations unless superseded by the requirements of these specifications.

Concrete thrust blocking is not recommended where the blocking may bear on other utilities or where the area behind the block may be excavated in the future.

A Town representative must inspect all blocking and anchoring prior to backfilling.

B. **Rodding:** Wedge-action restraint gland joint restraints shall be used for connecting 4-inch and larger valves and assemblies of fittings. When directed by

the Engineering Director**,** 4-inch and larger valves and assemblies of fittings shall be secured to a blocked fitting by stainless steel threaded rods with eyebolts. Refer to **Standard Detail 512.06** for the minimum size and number of rods needed for various test pressures. No more than one coupling shall be allowed between rods. Rodding length between fittings shall not exceed 20 feet. When the length between fittings exceeds 20 feet, place a thrust collar on the line and rod to the thrust collar.

All eyebolts and threaded steel rods shall be shall be type 316 stainless steel thread rods. See paragraph 2.3.13, Tie-Rods.

C. **Thrust Collars:** Thrust collars shall be constructed as shown in **Standard Detail 512.02** for pipes up through and including 36 inches in diameter. The thrust collar shall consist of a wedge action restrainer gland (see paragraph 2.1.2 Ductile Iron Fittings, paragraph B. 3 of this specification for manufacturer and model number of approved restrainer gland) placed around a joint of ductile iron pipe encased in a reinforced 3000 psi concrete block. Where the blocking provides thrust resistance for fittings, the Engineering Director may require threaded rods to be connected to the restraint flange fitting and secured to a full joint of ductile iron pipe. On dead end lines, the thrust collars must be placed on a full joint of ductile iron pipe just after the terminal end line valve.

3.3.3 VAULT CONSTRUCTION

During the contract, the contractor may be required to perform vault related construction. Prior to performing such work, all materials, specifications, and additional costs (items not bid in other sections,), shall be approved before commencing work.

3.3.4 MANHOLE INSTALLATIONS

Manhole bases shall be placed on a level 18-inch bed of #57 stone that has been thoroughly and firmly consolidated. Voids around the pipe, joints, grade rings, and other openings in the manhole shall be thoroughly and neatly grouted inside and outside with a non-shrink gout to prevent infiltration. A maximum of 2 grade rings or one grade ring and one course of concrete bricks will be allowed to bring the rim and cover to finished grade. If additional height is required, a riser must be installed.

Flat tops shall be used for air release manholes.

3.4 TESTING AND DISINFECTION

3.4.1 GENERAL

Pipelines shall be tested, in sections between valves, as soon as the installation is completed. Using this method, errors in workmanship can be identified immediately and leaks can be fixed quickly and with minimum expense. Prerequisite Conditions for Testing and Disinfection shall be as follows:

A. Pipelines and appurtenances have been laid and the trench backfilled.

B. Hydrants shall be properly located, operable and plumb and at correct elevation.

C. Valves shall be properly located, operable and at correct elevation. Valve boxes or manhole shall be centered over operating nuts and the top of the box or manhole shall be at proper elevation.

D. All services shall be installed complete with setters (Contractor shall provide a meter, approved by Town, for pressure testing). There shall be no bypass around the meter used for pressure testing.

E. All reaction anchors have had sufficient set of 7 days or high early strength concrete may be used to reduce the curing time to 3 days. For high early concrete mix, use 4,500-psi or greater concrete. Temporary bracing shall not be allowed.

F. Lines shall be properly vented where entrapped air is a consideration.

G. All visible leaks, broken or cracked pipe, valves, hydrants, etc. shall be repaired.

H. Air release valves shall be installed complete and in place after pressure test.

I. All construction activities on the project, that requires trenching or excavation within the limits of the water location shall be completed. Pavement base course and curb and gutter shall be in place before sampling. Pressure testing is to be performed before pavement is put down.

J. Approval from Town's Engineering Technician on section of line to be tested.

3.4.2 ORDER OF OPERATIONS

A. **Fill Line:** After all prerequisites are met, fill the system slowly with water, at a velocity of approximately 1 foot per second, while necessary measures are taken to eliminate all air at the highest points of the system where air may collect in pockets. After filling, shut off system in order to prevent contaminated water from flowing back in the line supplying the water.

B. **Pressure Test**: A pressure test shall be scheduled with a Town representative performing the test 48 hours in advance. Testing shall be in accordance with section 3.4.3, *Pressure Tests & Leakage*. ***If an existing gate valve is known to be leaking, chlorination must be performed prior to pressure testing.***

C. **Flushing:** Allow filled system to set undisturbed for a minimum of 24 hours, then begin flushing operations. The section of main to be disinfected shall be flushed through blowoff assemblies. Flushing shall be a velocity of not less than 2.5 feet per second to remove sediment and other foreign matter until the water runs clear. The contractor shall be responsible for making adequate provisions for drainage of large volume of flushing water, including proper dechlorination/disposal of chlorinated water. Any damages that may occur from this operation shall be the sole responsibility of the contractor. In conjunction with beginning flushing, a Town representative will perform a high range chlorine concentration test. Chlorine concentration of 50 mg/l minimum must be provided. Allow chlorinated water to set in the test section for 24 hours. The chlorine concentration shall not drop below 20 ppm within a minimum period of 24 hours. See section 3.4.4, *Disinfection and Bacteriological Testing*.

D. **Sampling**: Check chlorine and turbidity. After allowing the system to flush so that at least two volumes of water pass through the main, the bacteria sample shall be

collected at regular intervals not exceeding 1,200 feet, and tested for bacteriological quality. The contractor shall be responsible for making adequate provisions for drainage of large volume of flushing water, including proper dechlorination/disposal of heavily chlorinated water. See section 3.4.4, *Disinfection and Bacteriological Testing*.

1) Pipe subjected to contaminating materials shall be treated as directed by Engineering Director. Should such treatment fail to cleanse the pipe, replacement shall be required. The Town shall bear no portion of any cost sustained by the contractor in meeting this specification.

2) Services shall be included in the main line disinfection process. The contractor shall have the same responsibility for laterals as for the mains in regard to bearing full cost of any corrective measures needed to comply with either the bacteriological test or other such requirements.

3) After As-Builts have been submitted and reviewed, and NC State Certification of the water main has been received, the water main shall be placed in service.

E. **Final**: After final flushing, flow all hydrants to confirm the valves are open.

3.4.3 PRESSURE TESTS & LEAKAGE

The contractor shall test and disinfect completed sections of water line, including service lines, fire hydrants, and fittings with water. Town reserves the right to test all lines. This testing, however, does not relieve the contractor of his responsibility to repair or replace any cracked or defective pipe within the 12-month warranty period. All work necessary to secure a tight line shall be done at the contractor's expense. Testing shall be performed in the presence of Engineering Director.

All additions or replacements to water system, including fire lines and backflow prevention devices, shall be tested and chlorinated before being placed in service. Such work must take place under the supervision of Engineering Director.

The newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for two hours to a leakage test with a constant test pressure of 150% of design working pressure, but no less than 150 psi. The test pressure shall be allowed to build up slowly using a hand pump or power pump to the test pressure. Only Town personnel shall operate water valves on Town's existing water system. Extreme care shall be used to prevent backflow into the potable water supply. The lines should be allowed to stand under pressure for a period of 24 hours prior to the test. Air should be vented from all high points just prior to the test. Only clean water, free of dirt and other debris, from a clean container shall be used for testing. The contractor shall notify Town's Engineering Technician 48 hours in advance of any expected test. The contractor shall pretest all mains for a period of 2 hours before notifying Town for a final pressure test. No final pressure test will begin after 2:00 PM. The maximum allowable leakage shall be no greater than allowances shown in Table 6A, excerpted below (in accordance with Section 5.2, Table 6A - Hydrostatic Testing of AWWA C 600-173, AWWA Standard for *Installation of Ductile Iron Water Mains and Their Appurtenances*). For PVC pipe, the test procedure and allowable leakage shall be as specified in the latest edition of the Uni-Bell Plastic Pipe Association Handbook of PVC pipe, Chapter 11 *PVC Pressure Pipe Installation*. No leakage shall be allowed for services.

Tapping sleeve and valve shall be pneumatically tested in place prior to tapping of the existing line in accordance with the manufacturer's recommendations.

The Town's Engineering Technician will verify 1 pressure test – the final observation of the test section. A fee will be charged if the Town Engineering Technician is required to make more than 1 trip to verify a pressure test or conduct purity sampling on the same section of main being tested.

A. **Acceptance Tests:**

1) **Pressure Test**: Subject the pipe system to a hydrostatic pressure test. Raise the pressure by pump to 150-psi, 150% of design working pressure, or test pressure as shown on the drawings, whichever is greater. Measure pressure at the low point on the system compensating for gauge elevation. Maintain this pressure (+ or – 5 psi) for 2 hours. If pressure cannot be maintained using reasonable pumping rate, determine cause, repair, and repeat the test until successful. Contactor shall be responsible for all labor, materials, and equipment to perform the testing.

2) **Leakage Test**: Leakage shall be defined as the quantity of water that must be supplied into the pipe to maintain the test pressure, after all air in the pipeline has been expelled and the pipe has been tested for a duration of 2 hours. Leakage shall not exceed the quantity determined by Table 6A (excerpted from AWWA C600-93), attached. For allowable leakage for PVC pipe, refer to Uni-Bell Handbook of PVC Pipe, Table 11.4, *Testing Allowance for PVC Pipe, U. S. gal/h with Elastomeric Joints.*

If leakage exceeds allowances, the contractor shall be responsible for locating and repairing leaks, and retesting of line until successful.

No leakage will be allowed for all welded steel pipe. If leaks are revealed by test, repair by rewelding. Peening of leaks will not be allowed. A certified welder must perform all welding.

3.4.4 DISINFECTION AND BACTERIOLOGICAL TESTING

Pipe Disinfection and Bacteriologic Testing: comply with ANSI/AWWA C651, *Disinfecting Water Mains*. The contractor shall disinfect water mains and accessories in accordance with the procedures listed below and meet the requirements of Town. Bacteriological testing shall comply with Section 5 of AWWA C651. All samples shall be tested for bacteriological (chemical and physical) quality in accordance the *Standard Methods for the Examination of Water and Wastewater*; and shall show the absence of coliform organisms and the presence of chlorine residual. The lines shall not be placed in service or pressure tested until a negative bacteriological report has been received.

Samples cannot be collected if any type of precipitation is falling.

All sampling pipe shall be copper, brass, or PVC.

The contractor is responsible for furnishing all materials necessary for obtaining samples, for construction sampling points, and for taking the samples. Temporary

pipes used for sampling shall be composed of sections of vertical pipe terminating into a 90-degree horizontal bend and nipple at least 18 inches above ground level. Copper tubing used for sampling shall terminate horizontally with the ground, at least 18 inches above ground level. It may be difficult to obtain passing samples from outlets other than those listed above. Samples will not be taken from a hose.

The Contractor will prepare a Sampling Log, including a sketch of the sampling points, as specified by the Town. The samples shall be taken in standard sterilized bacteria sample bottlers marked with the sample location. The Contractor is responsible for collecting samples and doing so in the presence of a Town representative. Samples can only be taken Monday through Thursday no later than 1:00 PM. Chlorine injected on Friday yielding a 48-hour contact time will be reviewed and approved on a case by case basis.

Samples shall be delivered to a State certified testing laboratory for analysis. Results of the analyses shall be furnished to the Town directly from the testing laboratory with the project name and the testing location(s) referenced on each result. In the event that two successive bacteriological tests fail for any given section(s), that section(s) of the main shall be re-chlorinated, re-sampled, and re-analyzed.

Sampling Costs: Contractor is responsible for all testing costs.

Sampling Results: Sample results along with the Chain of Custody form are to be delivered to the Town.

A. **Forms of chlorine for disinfecting**

1) Calcium hypochlorite – Two forms are available – granular and tablets (both with 65% available chlorine). 6.5 lbs. of Calcium Hypochlorite will normally be required to produce a concentration of 50mg/L of available chlorine in 10,000 gallons of water. (Warning Note: *This chemical must not be used on solvent-welded or on screwed-joint steel pipe because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite*!)

2) Sodium hypochlorite – is supplied in strengths of 5.25% to 16% available chlorine. The required amount of sodium hypochlorite to produce a 50mg/L concentration of available chlorine in 10,000 gallons of water can be calculated from the following formula:

Gallons of Sodium Hypochlorite needed = 50 ÷ % of available chlorine

B. **Methods of chlorine application**

The contractor will inject a chlorine solution as specified in AWWA Standard C651, latest revision, into the water main. Chlorination shall be in accordance with the following guidelines for calcium hypochlorite granules:

Pounds of calcium Hypochlorite granules per 1000 feet of pipe to provide 50 ppm	
6-inch diameter pipe	0.93 lbs.

8-inch diameter pipe	1.68 lbs.
12-inch diameter pipe	3.77 lbs.
16-inch diameter pipe	6.71 lbs.
20-inch diameter pipe	10.50 lbs.
24-inch diameter pipe	15.11 lbs.
30-inch diameter pipe	23.61 lbs.

The chlorine solution shall be injected in the section of the main nearest an existing main. The chlorine solution shall result in a chlorination concentration of 50 ppm or greater. Chlorine injected on Friday yielding a 48 contact time will be reviewed and approved on a case by case basis. Manually operated pumps shall not be used to inject the solution into the main.

1) **Application for Tablet method** – This method shall be the primary method of applying chlorine to a water distribution system unless non-potable water or foreign materials have entered the mains or if the water temperature is below 5° C (41° F).

   The tablets shall be placed in each section and in all appurtenances. Enough tablets shall be used to ensure that a chlorine concentration of 50 mg/L is provided in the water. They shall be attached by an adhesive to the top of the pipe sections and crushed or rubbed in all appurtenances. The adhesive shall be approved for use in a potable water system. The velocity of the potable water in the main shall be less than 1 ft/sec. The water shall then remain in contact with the pipe for 24 hours.

   (Warning Note: *The procedure of using and placing calcium hypochlorite granules must not be used on solvent-welded or on screwed-joint steel pipe because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite*!)

2) **Application for Continuous Feed and Slug Method**

   Taps will be made at the control valve at the upstream end of the line and at all extremities of the line including valves. These taps shall be located in such a manner as to allow chlorine solution to be fed into all parts of the line.

   The chlorine solution shall be circulated in the main opening of the control valve while systematically manipulating hydrants and taps at the line extremities. The Chlorine solution must be pumped in at a constant rate for each discharge rate in order that a uniform concentration will be produced in the lines.

3) **Continuous feed method** – Potable water shall be introduced into the pipe main at a constant flow rate. Chlorine shall be added at a constant rate to this flow so that the chlorine concentration in the water in the pipe is a least 50mg/L. The chlorinated water shall remain in the main at least 24 hours, after which, the chlorine concentration in the water shall be at least 10mg/L. All valves and appurtenances shall be operated while the chlorinated water remains in the main.

4) **Slug method** – Potable water shall be introduced into the main at a constant flow rate. This water shall receive a chlorine dosage, which will result in a chlorine concentration of 100 mg/L in a "slug" of the water. The chlorine shall be added long enough to ensure that all portions of the main are exposed to the 100mg/L chlorine solution for at least 3 hours. The chlorine residual shall be checked at regular intervals determined by Engineering Director but not to exceeding 2,000 feet to ensure that adequate residual is maintained. As the chlorinated water passes valves and appurtenances, they shall be operated to ensure disinfecting of these appurtenances.

C. **Bacteriologic Tests - General**: Before the water main is placed in service, all samples shall be collected at regular intervals not exceeding 1,200 feet and tested for bacteriologic quality and shall show the absence of both background growth (gram positives) and coliform organisms.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. A chain of custody shall accompany the samples delivered to the plant. Test results cannot be read until 24 hours after sample has been run by lab. If laboratory results indicate the presence of coliform bacteria, the samples are unsatisfactory. If laboratory results indicate background growth masking the detection of coliform bacteria, the sample will be considered unsatisfactory. If the line fails second sampling, the main shall be re-chlorinated by the contractor and new tests performed prior to moving to the next section of main. The tablet method cannot be used in repeated disinfecting. Cleaning and disinfecting will be the responsibility of the contractor. Town will furnish water and operate all necessary valves for these operations. The contractor shall be responsible for loading, hauling, discharging of water, and dechlorinating device.

Samples for bacteriological analysis shall be collected for each section of pipe between main line valves after flushing is completed.

Primary sampling points are blow-offs (see the table of *Minimum Blow-off sizes*, paragraph D, below), 2-inch setters and all fire lines. Sampling will be allowed at hydrants if available to flush and sample the entire section of newly laid pipe. Otherwise, the contractor shall install a flushing and sampling tap consisting of a corporation cock installed in the pipe with a temporary copper pipe. Such additional work required for this shall be at the contractor's expense and is to be properly abandoned after acceptance.

D. **New Water Mains Disinfection and Purity Testing - Procedure**

STEP 1: Disinfection

The contractor is responsible for furnishing all taps and materials required to satisfactorily disinfect the water system. The following steps will be completed by Town and the Contractor cooperatively.

1) The Town's Engineering Technician will witness the flushing of the section of main to be disinfected until the water appears clear.

The contractor is responsible for adequate disposal of the large volumes of water generated from flushing and dechlorinating device.

2) The contractor will inject a chlorine solution as specified in Section 4 of the AWWA Standard C651, latest revision, into the water main.

   a. Do not use manually operated pumps to inject the solution into the main.
   b. The chlorine solution shall result in a chlorine concentration of 50 ppm or greater.
   c. The chlorine solution should be injected in the section of main nearest an existing water main.

3) The Town's Engineering Technician will draw water from the following areas until at least 50 ppm chlorine concentration has been measured at all points of discharge at which time each point will be closed:
   - end of the main
   - hydrants
   - lateral lines
   - other connections

   a. The Town's Engineering Technician will close all control valves feeding water into the main.
   b. The chlorine concentration shall not drop below 20 ppm within a minimum period of 24 hours.
   c. Sometime after the 24-hour period expires, the Town's Engineering Technician will check the chlorine concentration to confirm that it has not dropped below 20 ppm.

STEP 2: Preparing for Purity Testing

The contractor is responsible for furnishing all material and constructing sample points.

1) The Contractor is responsible for preparing a Sampling Log that includes a sketch of sampling points.

2) The contractor must ensure that each sample point terminates horizontally at least 18" above ground level.

3) **SAMPLES WILL NOT BE TAKEN FROM A HOSE.**

Samples are to be taken on Monday through Thursday, no later than 1:00 PM.

STEP 3: Purity Testing

The Contractor is responsible for collecting and submitting samples to a State certified testing laboratory. Samples cannot be collected if any type of precipitation is falling.

SAMPLING

1) Before chlorinating is performed, the Contractor will first flush the new water main. The main must be flushed so that two volumes of water pass through the main.

2) The Town's Engineering Technician will check both chlorine concentrations.

   a. The chlorine concentration must be less than 4ppm for consumption purposes but greater than or equal to 2 ppm for testing purposes.

   If the chlorine concentration is not within these limits, the Contractor must flush and rechlorinate the water line and resample at a later date.

3) If the chlorine concentration is within limits, the Contractor will collect samples from the new main and from an approved/control water main in the distribution system.

   Obtaining a control sample allows the laboratory to compare the water quality in the distribution system with that in the new water main.

4) On the day of collection, the Contractor will deliver the collected sample to a State certified laboratory. Samples may be delivered only Monday through Thursday no later than 1:00 PM.

5) The laboratory personnel will conduct a total coliform test using the membrane filter method. **This test required 24 hours of incubation before the result is obtained**.

6) The test results must be negative for coliform and E. Coli bacteria.
   a. If the samples from the water main are positive, the main must be disinfected again which means Step 1 must be repeated in its entirety. This will prolong testing.
   b. In the rare event that the samples from the control main are positive, the control main must be flushed and resampled at a later date. This will prolong testing.

E. **Dechlorination**: No discharge of heavily chlorinated water into a storm sewer or a stream will be permitted unless the discharge is first treated by a neutralizing chemical applied to the water to be wasted to neutralize throughly the residual chlorine. A dechlorinating device is required. Disposal of heavily chlorinated water shall meet the applicable sections of AWWA C651, latest revision.

3.5 FINAL ACCEPTANCE

A. Upon completion of water main installations and prior to acceptance, the Contractor shall provide adequate and competent personnel to conduct, in conjunction with Town, an inspection of each valve and hydrant on the newly completed main. The purpose of this inspection shall be to ensure the operability and location of each valve and to further ensure that all valves are left in the open position.

B. Fire hydrants shall be greased and painted.

C. Flow tests are to be performed on each hydrant to verify both that flows are in line with the design flows and that all line and leg valves are open.

D. Upon receipt of State Certification, the main valve serving the new section of main(s) shall be turned on and placed into service.

AWWA C600 TABLE 6A
ALLOWABLE PRESSURE TEST LEAKAGE
(Allowable Leakage per 1000 ft. of Pipeline * in gph)

(This table is excerpted from AWWA C-600, Section 5.2 Table 6A)

AVG. TEST PRESSURE PSI	NOMINAL PIPE DIAMETER-IN.																
	2	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450	0.32	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350	0.28	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300	0.26	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275	0.25	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225	0.23	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

*** For pipe with 18 ft. nominal lengths. To obtain the recommended allowable leakage for pipe with 20 ft. nominal lengths, multiply the leakage calculated from the table by 0.9. If the pipeline under test contains sections of various diameter, the allowable leakage will be the sum of the computed leakage for each size.**

END OF SECTION 02510

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02530 – SANITARY SEWER

(Last revised 9/27/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1 – General
Part 2 – Products
Part 3 – Execution

Bypass Pumping
CCTV Reg'ts
Concrete Encasements
Ductile Iron Pipe - spec
DIP Fittings
Flexible Sleeve Boots
Force Main Pipe Material
Iron Castings
Line Air Pressure Test - Table
Low Press Air Test Gravity Lines
Manhole Corrosion Protection
Manhole Markers
Manholes Precast - Spec
Manhole Vent Pipes
Manhole Vacuum Test
Mini-Manhole at Cleanouts
Pipe Laying
Pipe Separation Reg'ts
Pump Station & Force Mains
PVC Pipe
Residential/Commercial W/S Services
RFID Marker Balls
Service Connections
Steel Encasement Pipe
Testing
Tunneling
Tunnel Liners
UG Damage Protection
Valves: Air Release/Vacuum

PART 1 – GENERAL

1.1 GENERAL:

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to constructing all elements associated with the installation of gravity and/or pressure sanitary sewer systems (including pump stations and related equipment) as shown on the approved construction drawings and standard details and in accordance with provisions of these specifications and the Contract Documents.

Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a complete and compatible installation, coordinated with the work of all related trades

Work included in the project may consist of, but is not necessarily limited to, methods of installation of the following:

1) Sanitary Sewer Pipe Installation & appurtenances.

2) Sanitary Sewer Pump Stations, related site improvements, plumbing, electrical, and mechanical, as applicable.

3) Removal or relocation of existing sanitary sewer systems.

4) Buried Utility Structures associated with Sanitary Sewer Systems.

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The following materials and operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM standard specification references without a year designation implies the most current applicable specification.

1) The pipe and fittings shall be designed, manufactured, and installed in accordance with industry standards and shall comply with the specification requirements herein.

2) 02275 – Trenching, Backfilling, and Compaction of Utilities

3) American Concrete Institute (ACI) **ACI PRC-308-16** Guide to External Curing of Concrete

4) American Concrete Institute (ACI), **ACI CODE-318-19(22)**: Building Code Requirements for Structural Concrete and Commentary (Reapproved 2022)

5) **AWWA C600**: *Installation of Ductile-Iron Mains and Their Appurtenances*

6) **AWWA C605**: *Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings*

7) **AWWA C900**: *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings; (4" through 12")*

8) AWWA C906*: Polyethylene Pressure Pipe and Fittings*

9) **AWWA C150/A21.50**: *Thickness Design of Ductile Iron Pipe*

10) **AWWA M23**: *PVC Pipe – Design and Installation*

11) **ASTM C478**: *Standard Specification for Circular Precast Reinforced Concrete Manhole Sections*

12) **ASTM D638**: Standard Test Method for Tensile Properties of Plastics

13) **ASTM D1784**: *Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds*

14) **ASTM D2241**: Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

15) **ASTM D2412:** *Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*

16) **ASTM D2774**: *Standard Practice for Underground Installation of Thermoplastic Pressure Piping*

17) **ASTM D3034**: *Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings*

18) **ASTM D3035** (IPS, Refer to F714 and C906 for DIPS): *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter*

19) **ASTM D3139**: *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*

20) **ASTM D3212**: *Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*

21) **ASTM D3262**: *Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe*

22) **ASTM D3681**: *Standard Test Method for Chemical Resistance of "Fiberglass" (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition*

23) **ASTM D4161**: *Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals*

24) **ASTM F477**: *Elastomeric Seals (Gaskets) for Joining Plastic Pipe*

25) **ASTM F679**: *Polyvinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings*

26) **ASTM F714** (DIPS): *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter*

27) **ASTM F1417**: *Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air*

28) **ASTM F1483:** Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

29) **AASHTO M199**: *Standard Specification for Precast Reinforced Concrete Manhole Sections*

30) National Electrical Code (NEC)

31) National Electrical Manufacturers Association (NEMA)

32) **NFPA 70E**: Standard for Electrical Safety in the Workplace

33) North Carolina State Building Code: Building Code, Chapter 16, Structural Design

34) North Carolina State Building Code: Plumbing Code

35) **ASCE7-16**: *Minimum Design Loads and Associated Criteria for Buildings and Other Structure*

36) Standardization Rules of the American Institute of Electrical Engineers

37) Uni-Bell Handbook of PVC Pipe Design and Construction, Latest Edition

38) **UNI-B-6**: *Recommended Practice for Low-Pressure-Air Testing of Installed Sewer Pipe*

39) **UNI-B-9**: *Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inches)*

40) **UNI-PUB-06**: *Installation Guide for Solid-Wall PVC Sewer Pipe (4-15 inch; Clayton)*

41) **UNI-PUB-09**: *Installation Guide for Gasketed-Joint PVC Pressure Pipe*

42) **UNI-TR-3**: *Maintenance of PVC Sewer Pipe*

1.3 REFERENCED STANDARDS ORGANIZATIONS

A. Materials and operations shall comply with the latest revision of the Codes and Standards listed below:

AASHTO	American Association of State Highway Transportation Officials.
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
ANSI	American National Standards Institute
AREA	American Railway Engineers Association
ASCE	American Society of Civil Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CRSI	Concrete Reinforcing Steel Institute
FS	Federal Specifications
MSDS	Material Safety Data Sheets

NCDENR North Carolina Department of Environment and Natural Resources

NCDOT North Carolina Department of Transportation

NCMA National Concrete Masonry Association

NCPI National Clay Pipe Institute

NSF National Sanitation Federation International

OSHA Occupational Safety and Health Administration

UL Underwriters Laboratories, Inc.

WEF Water Environment Federation

1.4 SUMMARY

A. This section includes sanitary sewer piping and specialties for municipal sewer and services outside of building structures.

1.5 DEFINITIONS

A. **GENERAL**:

For the purposes of this specification, the following definitions refer to sanitary sewer collection and pressure systems that come under the authority of Town of Clayton as specified within this section and other sections of this manual.

1) **Cleanouts**: A riser pipe off of a service line that provides access to the line for the purpose of line cleaning.

2) **Competent Person**: Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

3) **Easement**: An instrument that depicts/describes and conveys rights and privileges to the Town for the placement, access to and maintenance of a utility line across and/or on the property of a second party. Ownership of the land remains with the second party.

4) **Engineering Director**: The Town's Director of Engineering or his or her authorized representative.

5) **Force Main:** Pressure sanitary sewer systems.

6) **Lift/Pump Station:** A combination wetwell/pump station and appurtenances.

7) **Plans:** The approved plans, profiles, typical roadway or trench sections, appropriate standard drawings, supplemental plans and working drawings,

or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

8) **Sanitary Sewer**: Exterior gravity or pressure public sanitary sewer systems.

9) **Sewer Service**: Exterior domestic sewer piping which connects to the public sewer system.

10) **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

B. The following are industry abbreviation for various pipe materials:

1) **AC**: Asbestos Cement Pipe
2) **CI**: Cast Iron Pipe
3) **CISP**: Cast Iron Soil Pipe
4) **DIP**: Ductile Iron Pipe
5) **HDPE**: High-Density Polyethylene
6) **RCP**: Reinforced Concrete Pipe
7) **PVC**: Polyvinyl Chloride Pipe

1.6 PERFORMANCE

A. Gravity Flow, Non-pressure Piping Pressure Ratings: At least equal to the system test pressure.

B. Force Main Pressure Ratings: At least equal to the system operating pressure plus 50 psi, but no less than 150 psi.

1.7 SUBMITTALS

A. Submit product data for the following. For third party projects, the Developer/Project Engineer shall perform all product review/certification and make a submittal at the end of the project to the Town. The engineer shall be duly licensed in North Carolina.

1) Piping Specialties.
2) Air & vacuum release valves and accessories.
3) SCADA.
4) Sewage Pumps and appurtenances, operating manuals.
5) Auxiliary Generators and/or Backup Pumps.
6) Alarm Devices.
7) Precast Concrete Manhole Castings & Iron Castings
8) Piping Paint.
9) Wetwell and/or Drywell interior coatings

B. Submit shop drawings for the following:

1) Precast concrete vaults and wetwells, including frames and covers, ladders, drains, access hatches, wall sleeves, valve support stands, pumps, and motors.

C. **Coordination Drawings**: Show manholes and other structures in vicinity, pipe sizes and elevations, elevations of lift station elements such as influent lines, floats, etc.

D. **Computations**:

1) Buoyancy calculations for wetwells, manholes, interceptor/outfalls, and mains with shallow cover.

2) Provide structural calculations for any elevated main and pier system where span of the main exceeds the joint length. Provide calculations for all aerial mains, and their supporting structures that are subject to hydrodynamic forces.

E. **Bypass Pumping**: Bypass pumping operations must be approved by the Town before starting. Provide a detailed written plan of how the bypass pumping operation shall be performed two weeks prior to the operation. See Section 3.6 of this specification.

F. **Project Closeout**: Submit 3 copies of manufacturer's maintenance and operation manuals on all sewage pumps and/or package lift stations and appurtenant devices.

1.8 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of the Codes and Standards listed in Section 1.2, above.

B. Piping materials shall be marked clearly and legibly.

1) Ductile Iron Pipe shall show on or near bell:

a. Weight,
b. Class or nominal thickness,
c. The letters "DI" or "Ductile,"
d. Manufacturer's identifying mark,
e. Year in which pipe was made, and
f. Casting period.

2) PVC pipe shall show identification marks, at intervals not to exceed 5 feet, as follows:

a. Nominal pipe diameter,
b. PVC cell classifications,
c. Company, plant, shift, ASTM, SDR and date designation,
d. Service designation or legend.
e. All PVC pipe shall bear the National Sanitation Foundation seal of approval.

3) Steel pipe shall be marked as follows. Each length of pipe and each special section shall be legibly marked by paint stenciling, die stamping or hot-roll marking to show the following:

a. Manufacturer's name or mark,
b. Size and weight of the pipe or special section,
c. The type of steel from which the pipe or special section was made.

C. *"Gravity Sanitary Sewer Design and Construction*," ASCE Manuals and Reports on Engineering Practice – NO. 60, WPCF Manual of Practice NO. FD-5.

D. AWWA C600: Installation of Ductile Iron Water Mains and Appurtenances.

E. NC Department of Environmental Quality, Division of Water Resources, NCAC Title 15A 2T .0200 *Waste not Discharged to Surface Waters*, latest revision.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

Materials used for the construction of gravity sewer, pressure mains and appurtenances in the Town's sewer collection system shall be new, free of defects, and meet the highest standards set forth. The Town's authorized representative must inspect, review, and approve all materials to be used for sewer main and appurtenances prior to installation. At the option of the Town, any material installed without inspection will have to be sufficiently removed for inspection and review. Any additions, deletions, or changes from the Town's approved plan set must be submitted to the Town for approval, prior to making changes in the field.

A. **PIPE CONDITION/PIPE EXAMINATION:**

1) **New Pipe Inspection**: Inspect materials thoroughly, including the interior, upon arrival. Examine materials for damage and to ensure that the right pipe has been delivered to the site. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications.

2) **Pre-Installation Inspection**: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipe damaged or deemed not to conform to these specifications shall be rejected and removed from site. All pipe in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells must be true. Examine bell and spigot for uniformity and smoothness of liner and barrel.

B. Protect pipe coating during handling using methods recommended by the manufacturer. Use of bare cables, chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.

C. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes to the satisfaction of the Town. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

D. Observe manufacturer's directions for delivery and storage of materials and accessories.

E. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.

F. Support pipe to prevent sagging or bending. Do not store plastic pipe, structures, and fittings in direct sunlight for more than one week.

G. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

H. Construct piping to accurate lines and grades and support as shown in the approved drawings or prescribed in the specifications. When temporary supports are used, ensure that sufficient rigidity is provided to prevent shifting or distortion of pipe.

1.10 PRODUCT SUBSTITUTIONS

Refer to the Town's Pre-Approved Product List (PAPL) for a list of approved manufactures and their products permitted on the Town's Water system. The Engineering Director, may at his/her discretion, approve materials not specified but deemed equal, on a case-by-case basis. If submitting new products, submit in writing with documentation and samples of materials to the Town of Clayton. New materials approved for the sewer collection system will be incorporated into these specifications after approval by the Town.

1.11 PROJECT CONDITIONS

1.11.1 SEPARATION OF WATER AND SANITARY AND/OR COMBINED SEWERS

A. Follow the NCDEQ standards for separation of water mains and sanitary sewers lines. See also **Standard Detail C01.05** for a visual representation of the following minimum separation requirements.

B. **PARALLEL INSTALLATIONS:**

1) **Preferred/Normal Conditions** – Sewer mains or sewer manholes shall be constructed at least 10 feet horizontally from water lines whenever possible. The distance shall be measured edge-to-edge.

2) **Unusual Conditions** – When local conditions or barriers prevent a horizontal separation of at least 10 feet, the sewer main or sanitary sewer manhole may be laid closer to a water line provided that:

a. The sewer line shall be placed in a separate trench, with elevation of the top of the sewer line at least 18 inches below the bottom of the water line; or

b. The sewer line shall be placed in the same trench as the water, and located to one side, on a bench of undisturbed earth, and the elevation of the top of the sewer line at least 18 inches below the bottom of the water main; or

c. If it is impossible to obtain proper horizontal and vertical separation as described above or anytime the sewer is above the water main, both the water main and sewer must be constructed of DIP complying with public water supply design standards and must be pressure tested to 150-psi to assure watertightness before backfilling. The sewer manhole shall be of watertight construction and tested in place.

C. **SEWER MAINS CROSSING BELOW WATER MAINS:**

1) **Preferred/Normal Condition** – sewer lines shall be constructed to cross below water lines whenever possible and shall be laid to provide a vertical separation of at least 18 inches between the bottom elevation of the water line and the top of the sewer.

2) **Unusual Conditions** – when local conditions or barriers prevent an 18 inch vertical separation as described in *Preferred/Normal Conditions* (paragraph immediately above), one of the following construction methods shall be used:

a. Both the water main and sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling.

or

b. Either the water main or the sewer main may be encased in a watertight encasement pipe which extends 10 feet on both sides of the crossing, measured perpendicular to the water main. The encasement pipe shall be of materials approved by NCDEQ for use in water main construction (e.g. DIP, steel). If the sewer main is encased, the DIP sewer carrier pipe shall be DIP continuous from manhole to manhole. If the water main carrier pipe is encased, the water shall be constructed of either DIP or PVC meeting these specifications.

D. **SEWER MAINS CROSSING ABOVE WATER MAINS:**

1) **Unusual Conditions** – when local conditions prevent an 18 inch vertical separation, as described in paragraph C, *Sewer Mains Crossing Below Water Mains*, *Preferred/Normal Condition*, above, the following construction shall apply:

a. Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling. The sewer line shall be ductile iron from manhole to manhole.

b. Provide adequate structural support for the sewers to prevent excessive deflection of the joints, which can result in settling on and/or breaking the water line.

E. **SEWER MAINS AND OTHER UTILITIES:**

1) **Horizontal Separation – Preferred/Normal Condition** – Sewer lines shall be constructed to provide at least 10 feet from water mains and 3 feet of horizontal separation from other utilities whenever possible. The distance shall be measured edge-to-edge.

2) **Vertical Separation – Preferred/Normal Condition** – Whenever it is necessary for another utility to cross a sewer main, a 12-inch vertical separation shall be maintained between the lines (see paragraph H, *Storm Drainage System*) for vertical clearances between sanitary sewers and storm sewers. When local conditions prevent a 12-inch vertical separation, the following construction shall apply:

a. Provide adequate structural support for the utility to prevent excessive deflection of the joints, which can result in settling on and/or breaking the sewer line.

b. The sewer line shall be constructed of AWWA approved Ductile Iron Pipe with material transition a minimum of 20 feet upstream from the intersection and shall continue to the next manhole.

F. **Sanitary Sewer Manholes**: No water main shall be allowed to pass through or come in contact with any part of a sewer manhole. A minimum of 3 feet of horizontal separation shall be maintained between water mains and sanitary sewer manholes provided that the applicable provisions of paragraph B, *Parallel Installations, Unusual Conditions*, above, are also met.

G. **SANITARY SEWER AND WATER SERVICES**: DEQ permits the collection system, not the taps into the sewer main except in the case of private permits. The Minimum Design Criteria for Gravity Sewers does not mention taps nor are they shown on the as-built drawing plan and profiles. As such, 15 NCAC 02T rules define a sewer service as follows:

> *Building Sewer* means that part of the drainage system that extends from the from a building and conveys the discharge from a single building to a public gravity sewer, private gravity sewer, individual sewage disposal system or other point of disposal.

The NC State Plumbing Code has an identical definition. Consequently, the separation requirements for water and sewer services fall under the requirements the *NC State Building Code: Plumbing Code (IPC with North Carolina Amendments),* Section 603.2 *Separation of Water Service and Building Sewer*, latest revision. Those provisions are generally as follows:

a. A minimum 12-inch vertical separation, with bottom of water service above the top of the sewer, and pipe material meets the provisions of Section 603.2 *Separation of Water Service and Building Sewer*.

Water service pipe and the building sewer shall be separated by 5 feet of undisturbed or compacted earth. The required horizontal separation distance of 5 feet shall not apply where the bottom of the water service pipe, located within 5 feet of the sewer, is not less than 12 inches above

the highest point of the top of the building sewer. However, in accordance with *Water & Sewer Design*, paragraph 1.2.1.R, *Water Distribution*, the horizontal separation between a water and sewer service within a public right of way or utility easement shall be no less than 3 feet. See **Standard Detail C07.03**).

b. Water can be located in same trench with sewer if pipe material meets the provisions of paragraph 603.2 and Table 702.2.

c. The required separation is not required where a water service pipe crosses a sewer pipe provided the water service is sleeved to a point 5 feet horizontally on either side of the sewer pipe centerline with pipe material meeting Table 605.3, Table 702.2 or Table 702.3 of the NC State Building Code: Plumbing Code, latest revision.

H. **Storm Drainage System**: Sewers shall be located a minimum of 5 feet from storm interceptor drains and 10 feet from surface drainage ditches or a stream, lake or impoundment. No gravity sewer or sewer lateral shall pass through a storm drain pipe or manhole system.

I. **New Utilities and Existing Sewer Mains**: When installing a new utility adjacent to or in close proximity to an *existing* sewer main, the new utility line shall be installed to provide the minimum horizontal and vertical clearances specified in paragraph E, *Sewer Mains and other Utilities*.

J. **Protection of Wells** – A distance of 100 feet shall be maintained between any private well and a gravity sewer, force main or manhole structure. If this separation cannot be maintained, DIP with joints equivalent to public water supply design standards and pressure tested to 150-psi to assure weathertightness, shall be used. However, given the sewer meets these requirements, no gravity sewer, force main, or manhole structure shall pass or be placed within 25 ft of a private well or 50 feet of a public water supply well, source or structure.

1.12 SERVICE INTERRUPTION

A. Contact the Town to coordinate interruption of services. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Engineering Director, temporary service may be required to be provided. Provide a minimum of 72 hours' notice of the proposed utility interruption.

1.13 COORDINATION

A. Coordinate tie-in to municipal sewer mains and manholes with the Engineering Director. Connections to the Town's sewer systems (manholes, wetwells, force mains or any other part of the sewer system) must be witnessed by a representative of the Town; otherwise, the Town will not accept the new system.

B. Service is to be continuously maintained to customers in the project areas except for the minimum amount of time required to make connections with the existing system. At the direction of the Engineering Director, temporary pumping/bypass of sewerage flow may be required to be provided. See paragraph 3.6, *Bypass Pumping* for bypass pumping requirements and procedure.

C. When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks' notice prior to anticipated disturbance or interruption. At the discretion of the Engineering Director, the notice may be required to be published in the newspaper.

D. Repair of pavement markings: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing. Repairs shall be made using either liquid Thermoplastic Traffic Marking Paint or Preformed Thermoplastic pavement marking materials.

E. Contact ***"NC One Call"*** at 811 before digging.



PART 2 – PRODUCTS

2.1 PIPE & FITTINGS

The following references provide the minimum standards as they apply to the specific item listed. In all cases, the latest revision shall apply.

2.1.1 DUCTILE IRON PIPE – Gravity or Force Main

Ductile iron pipe shall be Grade 60-42-10 and manufactured in accordance with all applicable requirements of AWWA C151/ANSI A21.51 and ASTM A746, Standard Specification for Ductile Iron Gravity Sewer Pipe for 4-inch and larger diameter pipe, thickness class rated, class 50 minimum. The thickness of Ductile Iron Pipe shall be determined by considering trench load in accordance with ANSI C150 and AWWA A21.50. (Public Sewers shall be no less than 8-inch diameter).

All pipe and fittings shall be lined with a minimum of 40 mils nominal dry film thickness of Protecto 401 Ceramic Epoxy when pipe is to be used for sewer only. Protecto 401 is an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Protecto 401 shall have a permeability rating of 0.00 when tested according to Method A of ASTM E96, Procedure A with at test duration of 30 days.

SewperCoat Alternate: SewperCoat calcium aluminate mortar lining, as manufactured by Lafarge Calcium Aluminates (or approved equal), is an acceptable alternative to Epoxy (Protecto 401) when pipe is to be used for sewer only. SewperCoat is a calcium aluminate mortar made of fused calcium aluminate cement and fused calcium aluminate aggregates. The thickness of the lining shall be the thickness identified on AWWA C104, Sec. 4.7, paragraph 4.7.1, latest revision but no less than 0.125 inch for 6-inch through 12-inch and 0.1875 inch for 14-inch through 24-inch pipe. The lining thickness may taper to less than the specified at the ends of the pipe. Cracks, other than closed hairline cracks and/or fine crazing shall not be acceptable. Loose areas of cement lining are not allowable. A seal coat shall be applied to the lining as identified on AWWA C104, Sec. 4.11.

Outside coat shall be a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.21 Section 51-8.1.

Each joint of ductile iron pipe, eighteen- or twenty-foot standard joint lengths, shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacturer to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

All materials used in production of the pipe are to be tested in accordance with AWWA C151 for their adequacy within the design of the pipe, and certified test results are to be provided to the Town upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

See the **Pre-Approved Products List** for a list of approved push-on and mechanical joint DIP manufacturers.

A. **DUCTILE IRON JOINTS:**

Pipe joints may be either push-on or mechanical joint pipe sizes 4 inches through 48 inches in diameter. Rubber Gasket Joints and Mechanical Joints shall comply with AWWA C111/ANSI A21.11, ASTM A536 *Standard Specification for Ductile Iron Castings*. Acceptable pipe joints are as follows:

1) **Push-on** Joint, Ductile Iron Pipe shall conform to AWWA C151/ANSI A21.51 (such as "Fastite" or "Tyton"). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWAC111/ANSI A21.11 *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*.

2) **Mechanical Joint, Ductile Iron Pipe** shall be used only at the specific locations indicated on the drawings or as approved by the Town.

   a. The mechanical joint shall consist of:

      i. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;

      ii. A pipe or fitting spigot;

      iii. A sealing gasket;

      iv. Separate ductile iron follower gland having cored or drilled bolt holes; and

      v. Ductile iron tee head bolts and hexagon nuts.

   b. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements

AWWA C111/ANSI A21.11, and ASTM A536 Standard Specification of Ductile Iron Castings.

c. **Mechanical Joint Bolt Torque**: See Section 3.1.2, paragraph B, *Mechanical Joint Bolt Torque*, below.

d. Mechanical joint pipe shall be UL Listed and FM Approved.

B. **DUCTILE IRON FITTINGS:**

Fittings shall be ductile iron at least class 54 thickness and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings. All ductile iron fittings shall have a minimum working pressure rating of 250 psi and minimum iron strength of 25,000 psi. All fittings shall be high alumina cement mortar lined in accordance with ANSI/AWWA C-104/A21.4 and the outside shall be bituminous coated. The fittings shall be tested and the manufacturer shall provide certified test results when requested by the Town. This testing shall include hydrostatic proof testing of fittings. Acceptable types of fittings include Push-On Joint and Mechanical Joint.

1) **Mechanical Joint Restraint (Restrainer) Systems** (3-inch through 48-inch)**:** Mechanical joint restraint systems shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Mechanical joint restraint systems (gland body, wedges and wedge actuating components) shall be constructed of ASTM A536, grade 65-45-12 ductile iron and shall conform to the requirements of either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.51. For applications requiring restraint 30 inches and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable provided the device meets all the end product performance requirements. An identification number consisting of the year, day, plant and shift, shall be cast into each gland body. Sizes 3-inch through 16-inch shall be rated at 350-psi minimum working pressure and sizes 18 inches and larger rated at 250-psi minimum working pressure. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes. Bolt heads are to be “auto-torque” twist off. Mechanical joint restraint systems shall accommodate all classes of ductile iron pipe (pressure class 350 through pressure class 150 and class 56 through 50) and appurtenances such as valves and hydrants without damage to the fitting, pipe or cement linings. Consult with manufacturer when use is intended for grey iron pipe. All components shall be manufactured and assembled in the United States. See **Standard Detail 512.02**, sheet 2 for figure.

Hardware (T-Bolts and nuts) to be grade 316 stainless steel; furnished by restraint gland manufacturer.

See the Pre-Approved Product List (PAPL) for approved restraint gland manufacturers.

C. **DUCTILE IRON SEWER SERVICES:**

Ductile iron pipe for sewer services shall be minimum thickness class 51 slip joint pipe with mechanical joint fittings. The service shall include the clean-out stack

provided with a cast iron ferrule with brass clean-out plug. See **Standard Detail 533.01**. See also sheet 4 of same detail for **Utility Shroud for Sewer Cleanout Assembly** located in easements.

2.1.2 PVC PIPE

A. **PVC SOLID WALL PIPE AND FITTINGS (GRAVITY PIPE)**

1) **PVC Solid Wall Gravity Pipe**: PVC Solid Wall Sewer Gravity Pipe and Fittings, Bell and Spigot Joints shall comply with ASTM D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 35 minimum (4 inches - 15 inches). For 18 inch diameter PVC, comply with the requirements of ASTM F679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings, or latest revision, type PSM. Pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 12364 C or 13364 B, with a minimum tensile modulus of 500,000 psi as defined in ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds, and shall be appropriately marked. Laying lengths shall be a minimum of 12.5 feet for pipes 15 inches or less and 11 feet for the pipes greater than 15 inches.

   PVC pipe strength shall be capable of withstanding stiffness, flattening, and impact test as scheduled or referenced in ASTM D3034 or ASTM F949. Smooth wall pipe shall have a Standard Dimension Ratio (SDR) of 35 or less. All PVC pipe shall have a minimum pipe stiffness of 46 psi when measured at 5 percent vertical ring deflection and tested in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

   With the exception of services, PVC Fittings shall not be used with pipes 4 inches and larger in diameter.

   See the Pre-Approved Product List (PAPL) for approved PVC gravity pipe Manufacturers.

2) **PVC GRAVITY PIPE JOINTS:** Joints for Solid Wall PVC Sewer Gravity Pipe & Fittings and (Elastomeric flexible seals (Gaskets) shall be compatible with pipe and shall meet the requirements of ASTM D3212 *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*. Rubber Gaskets shall be used which conform to the requirements of ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

B. **C900 PVC PIPE FOR GRAVITY SEWER AND SEWER FORCE MAINS (4-inch through 12-inch)**

1) C900 PVC gravity and pressure pipe, 4-inch through 12-inch, with bell end with gasket and spigot end shall comply with AWWA C900, Pressure Class 150, DR 18. Pipe shall also meet ASTM D2122, *Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings*, and ASTM D3139, *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*. Pipe shall have a bell with an integral wall

section with a factory installed, solid cross section elastomeric ring in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.*

2) The pipe shall be extruded from Class 12454A or 12454B PVC compound as defined in ASTM D1784. Stress due to working pressure cannot exceed the HDB[1] (4000 psi) ÷ 2.5 safety factor (HDS = 1,600 psi). The pipe outside diameters shall conform to dimensions of Ductile Iron Pipe. All pipe furnished shall be in conformance with AWWA C900, latest revision.

3) The minimum pipe stiffness shall be 364 psi.

4) In accordance with ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings,* a minimum pipe burst of 755 psi shall be withstood without failure.

5) The pipe must be able to withstand an impact of 100 foot-pounds without visible evidence of shattering or splitting as specified in ASTM D2444, *Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight*).

6) Pipe shall be homogenous throughout. It shall be free from voids, cracks, inclusion, and other defects. It shall be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces shall be free from nicks and scratches. Joining surfaces of spigots and joints shall be free from gouges and imperfections that could cause leakage.

7) Each length of pipe furnished shall bear identification marking that will remain legible after normal handling, storage, and installation. Markings shall be applied in a manner that will not weaken or damage the pipe. Markings shall be applied at intervals of not more than 5 feet on the pipe. The minimum required markings are given in the list below. Marking requirements shall be in conformance with AWWA C900.

   a. Nominal Size and OD Base (e.g. 12CI)
   b. PVC
   c. Dimension Ratio (e.g. DR 18)
   d. AWWA pressure rating (e.g. PR 150)
   e. AWWA designation number (AWWA C900)
   f. Manufacturer's name or trademark
   g. Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture.

8) C900 pressure pipe for force mains shall be used with ductile iron fittings (restrained joint).

   See the Pre-Approved Product List (PAPL) for approved C900 PVC Pipe Manufacturers.

C. **C905 PVC PIPE FOR GRAVITY SEWER MAINS (14-inch through 24-inch)**

[1] Hydrostatic Design Basis

1) AWWA C905 PVC gravity pipe, 14-inch through 24-inch, with bell end with gasket and spigot end, shall comply with AWWA C905, Minimum Pressure class 160, DR 18. Pipe shall also meet ASTM D2122, *Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings*, and ASTM D3139, *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*. Pipe shall have a bell with an integral wall section with a factory installed, solid cross section elastomeric ring in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.*

2) The pipe shall be extruded from Class 12454A or 12454B PVC compound as defined in ASTM D-1784. Stress due to working pressure cannot exceed the HDB[2] (4000 psi) ÷ 2 safety factor (HDS = 2,000 psi). The pipe outside diameters shall conform to dimensions of Ductile Iron Pipe. All pipe furnished shall be in conformance with AWWA C905, latest revision.

3) Pipe shall be homogenous throughout. It shall be free from voids, cracks, inclusion, and other defects. It shall be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces shall be free from nicks and scratches. Joining surfaces of spigots and joints shall be free from gouges and imperfections that could cause leakage.

4) Each length of pipe furnished shall bear identification marking that will remain legible after normal handling, storage, and installation. Markings shall be applied in a manner that will not weaken or damage the pipe. Markings shall be applied at intervals of not more than 5 feet on the pipe. The minimum required markings are given in the list below. Marking requirements shall be in conformance with AWWA C905.

    a. Nominal Size and OD Base (e.g., 14CI)
    b. PVC
    c. Dimension Ratio (e.g., DR 18)
    d. AWWA pressure rating (e.g., PR 160)
    e. AWWA designation number (AWWA C905)
    f. Manufacturer's name or trademark
    g. Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture

See the Pre-Approved Product List (PAPL) for approved C905 PVC Pipe Manufacturers.

D. **DIRECTIONALY BORED HDPE PIPE FOR SEWER FORCE MAINS**

1) All polyethylene pipe, tubing, and fittings shall conform to all applicable provisions and requirements of the latest revision of AWWA C901 DIPS, AWWA C906 DIPS, or CSA B137.1 and, by inclusion, all appropriate standard references therein. Polyethylene compounds utilized in the manufacture of products furnished under this specification shall have a grade of PE24 with a minimum cell classification of PE 234363(C, D, or E)

[2] Hydrostatic Design Basis

for PE2406-2606 materials, or a grade of PE34 with a minimum cell classification of PE 345464(C or E) for PE3408/PE3608 materials, as defined in ASTM D3350. In conformance with AWWA C901, AWWA C906, or CSA B137.1, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1250 psi (PE2406/2606) or 1600 psi (PE3408/PE3608) at a temperature of 73.4°F (23°C).

All materials which come in contact with water, including lubricants, shall be evaluated, tested, and certified for conformance with ANSI/NSF Standard 6.1.

Clean re-work material of the same type grade, and cell classification generated from the manufacturer's own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing, and fittings produced meet the requirements of AWWA C901, AWWA C906, or CSA B137.1.

2) **Reference standards**

AWWA C901: Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service.

AWWA C906: Polyethylene (PE) Pressure Pipe and Tubing, 4-inch through 63-inch for Water Service.

ASTM D2657: Standard Practice for Heat Joining Polyolefin Pipe and Fittings.

ASTM D2683: Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis of Thermoplastic Pipe Materials.

ASTM D3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

ASTM F714: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

ASTM F1055: Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

PPI TR-3: Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

PPI TR-4: Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fitting Compounds.

ANSI/NSF: Standard Number 61 for Drinking Water Systems Components – Health Effects.

NSF Standard #14: Plastic Piping Components and Related Materials.

CSA B137.1: Polyethylene Pipe, Tubing, and Fittings for Cold Water Pressure Services.

3) **Qualification of Manufactures**

The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. Given reasonable notice, the manufacturer's production facilities shall be open for inspection by Town or their representative. See the Pre-Approved Product List (PAPL) for approved HDPE pipe manufacturers.

4) **Manufacturer's Quality Control**

The manufacturer of the Polyethylene pipe and fittings shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in AWWA C901 or AWWA C906, as applicable.

5) **Pipe and Tubing**

Pipe and tubing furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above. Dimensional performance characteristics shall conform to the requirements of AWWA C901, C906, or CSA B137.1. The pipe's DR (Dimension Ratio) and Working Pressure (WPR) shall be as specified or shown on the drawings.

6) **Fittings**

Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above and all appropriate requirements of AWWA C901, C906, or CSA B137.1 Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings produced from material not listed in paragraph 1) above, shall be approved only after submission of appropriate test data and service histories indicating their acceptability for the intended service. In all cases, the specifications and requirements of the fittings supplied shall comply with the appropriate section of AWWA C901, C906, or CSA B137.1.

7) **Pressure Class**

The Pressure Class of the Polyethylene pipe and fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to one half of

the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's nominal pressure class may be ignored due to the fatigue endurance of the polyethylene materials. Non-polyethylene fittings shall be specified and used in accordance with the surge tolerance of the particular appurtenance in use.

8) **Marking**

Pipe and tubing shall be marked in accordance with either of AWWA C901, AWWA C906, or CSA B137.1, whichever applies. Marking shall be legible and shall remain legible under normal handling and installation practices. Indent marking may be utilized provided; 1) the marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing, 2) it has been demonstrated that these marks have no effect on the long term strength of the pipe or tubing and, 3) the marks do not provide leakage channels when elastomeric gasket compression fittings are used to make the joints.

Fittings shall be marked on the body or hub. Marking shall be in accordance with either ASTM D2683, ASTM D3261, AWWA C906, or ASTM F1055, depending on fitting type and the standard that applies. Mechanical fittings shall be marked with size, body material designation code, pressure rating and manufacturer's name or trademark.

9) **Workmanship**

Pipe, tubing, and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects. The pipe, tubing, and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical prosperities.

E. PVC PIPE FOR SERVICE CONNECTIONS

Pipe for 4-inch and 6-inch service connections shall be schedule 40 solid wall PVC pipe with solvent cement weld joints meeting ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120* and ASTM D2564, *Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.* In-line wyes shall be used for all service connections to new lines. Connections to existing mains shall be made by the using an in-line wye with an approved adapter to splice the in-line wye into the sewer main. The service shall include the in-line wye, bends, long sweep wye, and clean-out stack provided with a brass clean-out plug. See **Standard Detail 533.01**.

Use of saddles for service connections (**Standard Detail 533.02**) shall be approved by the Engineering Director on a case-by-case basis.

See the Pre-Approved Product List (PAPL) for approved Pipe Manufacturers.

F. SERVICE SADDLES:

See the Pre-Approved Product List (PAPL) for approved service saddle Manufacturers. See **Standard Detail 533.02**.

Use of saddles for service connections (**Standard Detail 533.02**) shall be approved by the Engineering Director on a case-by-case basis.

2.1.3 STEEL PIPE (Use of steel pipe - approved on a case-by-case basis)

A. **STEEL PIPE FOR SEWER MAINS, AERIAL CREEK CROSSINGS, ENCASEMENT, BORING APPLICATIONS, AND VENT PIPES:**

Pipe shall be unwrapped high strength steel, spiral welded or smooth-wall seamless manufactured in accordance with ASTM A139 *Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over) and ASTM A283/A283M Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates,* Grade "B" steel with a minimum yield strength of 35,000 psi (minimum tensile stress of 60,000 psi) or ASTM A252 *Standard Specification for Welded and Seamless Steel Pipe Piles*, Grade 2 steel with a minimum yield strength of 35,000 psi. All encasement pipes shall meet the applicable NCDOT, Municipal, or AREA specifications but shall be no less than 6 inches larger than the outside diameter of the carrier pipe bell. The steel pipe shall be capable of withstanding the design load. No interior lining and exterior coating shall be required except that all exposed metal is to be coated with epoxy or asphaltic material. The pipe shall have welded joints and be in at least 18-foot lengths.

1) **Steel Pipe for Gravity Sewer Mains**: Pipe shall be seamless and either furnace-welded or electrically welded pipe, Grade A. The exterior coating shall be coal-tar enamel in accordance with AWWA C203.

2) **Steel Pipe for Aerial Creek Crossings** (*without encasement and carrier pipe*): The outside of the pipe shall have one coat of zinc chromate primer conforming to Federal Specification TT-86-a and afterwards painted with coal-tar enamel.

3) **Steel Encasement Pipe for Boring Applications:** Encasement pipe shall meet applicable NCDOT and AREA specifications. Casing pipe shall include pipe carriers (spiders) to support carrier pipe.

   a. **Spiders/Skids for Encasement Pipes**: Spacers used to support and center carrier pipe and to insulate/catholically protect a pipe line from a casing pipe through which it must pass. Band to be minimum 14-gauge, T-304 Stainless Steel with a minimum 10 ga T-304 Stainless Steel riser and T-304 SS bolts, washers, and nuts. Liner on band to be EPDM.

      Runners/Risers to be 1" or 2" wide glass filled polymer plastic; band lengths minimum 7" up to 12". All risers to be welded to the band by MIG welding. Unless otherwise noted on plans or specified, band is to have 4 equal legs for carrier pipe 16" and under; 5 legs for carrier pipe 18" to 24" and 6 legs for pipe 30" to 42". Stainless steel welds are fully passivated to prevent corrosion.

      See paragraph 3.1.4.B and **Standard Details C07.01** for location of spiders.

See the Pre-Approved Product List (PAPL) for approved Casing Spacer/Insulator Manufacturers.

b. **Steel Casing End Seals**: Casing end seals shall be 1/8" thick synthetic rubber seamless pull-on end seals with T-304 stainless steel banding with 100% non-magnetic worm gear mechanism. End seals shall permit pipe movement while maintaining a seal.

See the Pre-Approved Product List (PAPL) for approved End Seal Manufacturers.

4) **Steel Vent Pipes for Sanitary Sewer Manholes**: The vent pipe shall be made from Schedule 40 Stainless Steel. See **Standard Detail 532.10**.

2.1.4 TUNNEL LINERS

A. Carrier pipe shall be mechanical joint or restrained joint ductile iron pipe pressure class 350 psi.

B. Grout for Pressure Grouting: Sand/cement mortar mix for filling voids in between carrier pipe and tunnel shall consist of the following materials properly mixed in proportions by weight.

1) 1.0 Part Cement, ASTM C150, Type I/II.

2) 3.0 Parts Fine Sand, 100 Percent Shall Pass No. 16 Sieve.

3) 0.5 to 0.6 Part Water – water should be sufficient to provide a consistency of thick cream when well mixed.

4) 2% approved additive (Bentonite, Septamine Seaex, Hydrocide liquid, etc.).

5) Minimum unconfined compressive strength: Minimum 7-day unconfined compressive strength of 500-psi for sand-cement mortar grout; 300 psi for cellular grout.

C. Tunnel lining construction shall comply with the "*Specification for Steel Tunnel Liner Plates"* in the American Railway Engineering Association (AREA) Manual for Railway Engineering, latest revision and AASHTO Standard Specification for Highway and Bridges, latest edition. The design and shape of the liner plates shall be such that erection and assembly of the liner plate structure can be completely and readily effected from inside the tunnel. Plates shall be accurately curved to suit the tunnel cross section, and all dimensions shall be of the size and accuracy such that plates of similar curvature shall be interchangeable. All plates shall be connected by bolts on both longitudinal and circumferential joints.

D. The steel lining shall consist of plates 16, 18, or 24 inches wide. Each circumferential ring shall be composed of the number and length plates necessary to complete the required shape shown on the drawings. The nominal tunnel diameter shall be of sufficient size to install the carrier pipe.

E. Plates shall be one-piece steel meeting the requirements of ASTM A1011 *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*, or ASTM A1008 *Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable*. Plates shall have an ultimate tensile strength of at least 42,000 psi and yield strength of 28,000 psi. Nominal plate dimensions shall provide the sectional properties shown in Article 1.13.9 (or latest update) of the AASHTO Standard Specifications for Highway Bridges. Thickness tolerances shall conform to Paragraph 14 of AASHTO M 167M *Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches*. Gage thickness shall be a minimum of 8 gage. The liner plate and bolts shall be galvanized in accordance with ASTM A153 *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*. In addition, the liner plates shall be asphalt coated to meet AREA Article 1.14.13 (or latest update). For two flange plates, the minimum thickness shall be 0.135 inches. Plates shall be manufactured by Armco Steel Corporation, Commercial Shearing, Incorporated, Republic Steel Corporation, or equal.

F. Grout holes 1½ inches or 2 inches (or larger) in diameter shall be provided in each ring to permit grouting as the erection of the tunnel liner plates progresses. Grout hole screw plugs shall be provided in plates.

The minimum provision for grouting openings shall be one opening in a top plate of the tunnel at locations not to exceed 54" apart. Additional plates with grouting openings are to be installed at the top quarter points on each side between the top openings. The opening shall be staggered, but shall not exceed 54" in any one line. Grout vent pipes will be required at a minimum of one per monolithic pour.

G. Steel bolts shall meet requirements of ASTM A449 *Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use* for plate thickness equal to or greater than 0.209 inch and ASTM A307 *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength* for plate thickness less than 0.209 inch. The nut shall meet requirements of ASTM A307, Grade A.

See the Pre-Approved Product List (PAPL) for approved steel pipe Manufacturers.

2.1.5 CARRIER PIPE FOR CASINGS AND TUNNELS

Carrier pipe shall be mechanical joint ductile iron pipe of the class indicated on the drawings. See paragraph 2.1.1, Ductile Iron Pipe.

2.2 MISCELLANEOUS APPURTENANCES AND MATERIAL

2.2.1 GATE VALVES

Gate valves shall follow the specifications as written in 02510 – *Water Distribution*, paragraph 2.2.6.

2.2.2 PLUG VALVES

Plug valves shall be non-lubricated, eccentric type with resilient faced plugs and with mechanical joint ends for buried service. Port area shall be at least 80% of the full pipe area. Bodies shall be semi-steel or cast iron. Seats shall have a welded in overlay of not less than 90% pure nickel on all surfaces contacting the plug face. Valve shall have stainless steel permanently lubricated upper and lower plug stem bushings. Valves shall be of the bolted bonnet design, and shall be designed so that they can be repacked without removing bonnet from valve. All nuts, bolts, springs, and washer shall be cadmium plated.

All plug valves 6" and greater shall be equipped with an actuator. All gearing shall be enclosed, suitable for running in oil, and the actuator shall be submersible with seals provided on all shafts to prevent entry of water into actuator shall clearly indicate valve position and an adjustable stop shall be provided with a nut operator and extension stem of suitable length.

Valves shall be as manufactured by Dresser, DeZurik, Keystone, Kennedy or approved equal.

2.2.3 VALVE BOXES

Gate valve Valve Boxes shall follow the specifications as written in 02510 – *Water Distribution*, paragraph 2.3.14.

2.2.4 AIR RELEASE AND VACUUM VALVES

Combination Air Release and Vacuum (AR&V) valves are to be used to bleed air during filling of wastewater force mains and to automatically vent air that collects in the force mains. Valves are to be self-flushing at pump shutdown and valve emptying.

AR&V valve Body, flanges, hardware, trim and venting orifices, and the primary and secondary floats are to be of minimum ASTM A240 304L or 316L Stainless Steel. All AR&V valves shall have a male NPT threaded nipple inlet.

As applicable to the specific approved AR&V valve, the valve body shall be internally constructed to provide an unobstructed circular space between the UHMW (Ultra-High-Molecular-Weight) PE floats and inner valve body wall. Inlets, outlets, and internal clearances are to have a cross-sectional area at least equal to that of the valve's nominal size. Valves shall include an upper gauge port and lower flushing port and these ports shall be of the same material as the valve body. Both the upper and lower ports are to have male NPT threaded ends and come equipped, as applicable to the approved AR&V valve model, with a full port SS ball valve.

Valves shall be designed and rated for internal working pressures of 3 to 145 psi or greater working pressure. Valve bodies shall be tested to a minimum 1.5 times the system pressure specified and shall not experience leakage or deformation. The valve size shall be the nominal size of its connection fitting. AR&V valves to have integral protection from water hammer and surge.

Combination air release and vacuum valves shall be located as shown on the drawings or as otherwise directed by the Town. The valve shall be housed in a

precast concrete manhole and shall be installed in accordance with **Standard Detail 534.06**.

See the Pre-Approved Product List (PAPL) for approved SS Air Release & Vacuum Valve Manufacturers/product models.

2.2.5 BEDDING

A. Bedding material, shall be clean coarse aggregate No. 57 or smaller, and shall meet the requirements of Section 1005 of the NCDOT Standard Specifications for Roads and Structures.

1) **Minimum Bedding Allowed**: The minimum bedding depth shall be 3 inches under the pipe with an additional 1-inch depth of cushioning material added for each additional 2 feet of depth in excess of 16 feet up to a maximum of 12 inches of cushioning material. Pipe shall be bedded to the spring line of the pipe. See **Standard Detail 531.01**.

2.2.6 SOLID BRICK (for manhole adjustments)

Sold clay brick for manhole adjustments shall be hard clay, grade SM, ASTM C 32, *Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)* and AASHTO M91.

See paragraph 2.2.8 for concrete block specifications.

2.2.7 CONCRETE

Concrete classes (NCDOT) to Design Compressive Strength at 28 days (f'c):

Class	28-day Compressive Strength (f'c)
AA	4,500 psi
A	3,000 psi
B	2,500 psi

Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete.* All exposed concrete shall be air entrained. Concrete strength shall be as specified on the Standard Details and drawings. Unless otherwise specified, all concrete shall be minimum class A.

2.2.8 CONCRETE BLOCK (for manhole adjustments)

Solid concrete block for manhole adjustments shall conform to the requirements of ASTM C139 *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*.

Concrete block shall conform to the requirements of ASTM C139, *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*.

2.2.9 MORTAR FOR CONCRETE BLOCK & CLAY BRICK

Mortar shall be type M, ASTM C 270, *Standard Specification for Mortar for Unit Masonry* and ASTM C-144, *Standard Specification for Aggregate for Masonry Mortar.* Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No mortar that has stood beyond forty-five minutes shall be used. Proportion by volume for the different types of application shall be as follows:

Clay Brick or Concrete Block =		1 part cement to 2 parts sand
	Pointing =	1 part cement to 1 part sand

Type M mortar will typically produce mortar meeting the requirements of ASTM C270 under the proportion specifications.

2.2.10 IRON CASTINGS: MANHOLE FRAMES AND COVERS

A. **General**: Manhole frames and covers shall be manufactured from Class 35B gray iron, meeting the requirements of ASTM A48*, Standard Specification for Gray Iron Castings,* as noted in section 3.1 of AASHTO M105 & M306. Standard manhole frames and covers shall be built to the dimensions and configurations shown on **Standard Details C06.01** and **C06.02.** Minimum inside diameter of the opening shall be 23 ½ inches. Manholes castings are to be heavy duty uncoated. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Covers are to be embossed along the perimeter with the name "TOWN OF CLAYTON" and with the words "Sanitary Sewer" and "Confined Space." See **Standard Details C06.01** and **C06.02**.

Watertight Frames and Covers: Watertight bolt-down frames and covers shall have 4 stainless steel bolts at 90 degrees. Frame is to have (4) 1-inch diameter holes in flange at 90 degrees. Bolt down frames and covers are to be utilized whenever a manhole top is set lower than 1-foot above the 100-year base flood elevation.

B. Approved castings are:

See the Pre-Approved Product List (PAPL) for approved iron casting Manufacturers.

Note: Weights shall not deviate by - 5% from that shown in the above table.

If the top of the manhole is less than 1-foot above the 100-year base flood elevation, a bolt-down watertight frame and cover is to be used.

C. **Bolting Down Watertight Frames to Manhole**: For units not cast into the manhole top, frame shall otherwise be drilled and bolted into cone sections with a minimum of 4 bolts. Bolts shall be stainless steel expansion bolts by manufacturers such as Hilti, Rawl or Liebig. This requirement shall apply for watertight frames and covers only. See **Standard Detail C06.02**.

2.2.11 IRON CASTINGS: SEWER CLEANOUT BOX

General: Sewer cleanout frames and covers shall be manufactured from Class 30 gray iron, meeting the requirements of ASTM A48, *Standard Specification for*

Gray Iron Castings. Standard sewer cleanout frame and covers shall be built to the dimensions and configurations shown on **Standard Detail 533.01**.

See the Pre-Approved Product List (PAPL) for approved cleanout box Manufacturers.

2.2.12 MANHOLE (PRECAST) EXTERIOR JOINT SEALANT

All buried joints of manhole castings shall be sealed to the structure with an external sealing system. The seal shall be continuous bands, made of high quality EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 30 mils, minimum 12 inches wide, stretchable, and self-shrinking meeting ASTM C877, Type III, ASTM C923. The mastic shall be non-hardening butyl rubber sealant and shall seal to the risers. See **Standard Detail 532.11**.

See the Pre-Approved Product List (PAPL) for approved manhole flexible exterior joint sealant Manufacturers.

2.2.13 MANHOLE FLEXIBLE INTERIOR COATING SEALANT (FLEX-SEAL)

When called for on the Standard Manhole Details, an internal sealant system shall be applied to prevent leakage of water into the manhole though the frame joint area and the area above the manhole cone including all extensions to the chimney area, or as otherwise directed by the Engineering Director. The seal shall remain flexible allowing for repeated vertical or horizontal movements of the frame due to frost lift, ground movement, or the thermal movement of pavement. The product shall have a minimum elongation of 800% and a Durometer hardness of 75. The manhole sealant shall conform the physical requirements of ASTM D412 *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension* with a minimum of 170 mils thickness for durability and resistance elongation and tearing. The lining product shall have an aromatic urethane primer resin on the complete surface. Sealant shall equal or exceed “Flex-Seal” as manufactured by Sealing Systems, Inc., Loretto, MN. See **Standard Detail 532.11**.

2.2.14 MANHOLE INSIDE DROP BOWLS

Manhole inside drop bowls to be highly resistant to sewer acids and constructed from marine grade fiberglass finished in bright white gel coat. Bowls shall equal or exceed drop bowls manufactured by RELINER/Duran, Inc. The drop bowls size shall be determined by incoming pipe size and flow rates for retrofit or new construction. The bowl shall be installed as per manufacturer’s instructions. The connection of the drop bowl to drop pipe shall be by flexible external pipe coupler.

Clamping pipe supports to be manufactured from 11 Ga. non-magnetic 304 stainless steel with 18-8 stainless steel nuts and bolts. **See Standard Detail; 532.09**.

2.2.15 MANHOLE MARKERS

Manhole markers are furnished and installed by the Contractor over sewer line outside of pavement. See **Standard Details 532.03** and **539.01.**

2.2.16 PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement*.

2.2.17 PRECAST REINFORCED CONCRETE STRUCTURES

A. **Precast Concrete Manholes:** Manholes of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, or latest revision. Manhole diameters shall be 4-ft. minimum. The wall shall be a minimum of 5 inches thick and have a 6-inch minimum base. Either an "O" ring or "ram neck" flexible joint seal shall be used. The "O" ring joint shall conform to the requirements of ASTM C443*, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets* or latest revision. The gasketed joint shall conform to ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants* (or AASHTO M-199) or latest revision. Rubber boot and stainless steel clamps, meeting the requirements of ASTM C923, *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, shall be supplied with the manhole bases to tie the pipe to the base section of the manhole. Concrete used in the construction of the manholes shall have a minimum 28-day strength of 4000-psi air entrained (with 4 to 6 percent air) Type II cement concrete conforming to ASTM C33*, Standard Specification for Concrete Aggregates* and ASTM C94/C94M, *Standard Specification for Ready-Mixed Concrete*. Manhole units shall consist of standard modular precast riser sections, modular riser sections, and a monolithic base (except doghouse bases are to be used when placing manholes over existing mains). Where conditions do not favorably accommodate the use of an eccentric cone, eccentric precast reinforced concrete flat tops are to be used. In areas of high H_2S concentration, provide protection of manhole by providing linings or coatings on the interior of the manhole such as Polyethylene, PVC, Reinforced Thermosetting Resin (RTR), "Strong-Seal," or coal-tar epoxy. Alternatively, Polymer Concrete Manhole and grade rings may be otherwise required when ordered by the Engineering Director.

Unless otherwise permitted by the Town, manholes will be precast reinforced concrete. Brick or block manholes are not permitted.

Refer to the **Standard Detail 532.01** for boot to pipe connection detail.

Extended Bases: Manholes over 12 feet in depth, as measured from top of casting to effluent invert, shall have extended bases with appropriate reinforcing. Also, manholes over 12 feet in depth shall also be a minimum of 5-foot diameter. See **Standard Detail 532.03** and **532.05**.

Exterior Joint Seal: All buried riser and cone sections mating with riser sections shall have a flexible exterior joint sealant placed on the circumference of the manhole and centered with the buried manhole joint. See also **Standard Details 532.03, 532.05,** and **532.07**. See the Pre-Approved Product List (PAPL) for approved flexible exterior joint sealant Manufacturers.

Butyl Rubber Joint Sealant: Butyl rubber joint sealant shall meet the requirement of FS SS-S-00210 (210-A), ASTM C990, Type 1, Rope Form, ¾" diameter (min.). See the Pre-Approved Product List (PAPL) for approved Butyl Rubber Joint Sealant Manufacturers.

2.2.18 Polymer Concrete Manholes & Grade Rings

A. **Polymer Concrete Manholes**

1) Provide polymer concrete manhole sections, monolithic base sections and related components referencing to ASTM C478. ASTM C478 material and manufacturing is allowed compositional and dimensional differences required by polymer concrete product.

2) Provide base riser section with monolithic floors, unless shown otherwise.

3) Provide riser sections joined with bell and spigot / ship-lap design seamed with butyl mastic and/or rubber gaskets (ASTM C990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure.

4) Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints.

5) Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer.

6) Provide tops to support AASHTO HS-20 or HL-93 or vehicle loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings.

B. **Design Criteria:**

Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.

1) AASHTO HS-20 or HL-93 design or as required loading applied to manhole cover and transition and base slabs.

2) Polymer manholes will be designed based upon live and dead load criteria in ASTM C857 and ACI 350.

3) Unit soil weight of 120 pcf located above portions of manhole, including base slab projections.

4) Internal liquid pressure based on unit weight of 63 pcf.

5) Dead load of manhole sections fully supported by polymer concrete manhole base.

C. **Design:**

Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C478, ASTM C857 and ACI 350 as modified for polymer concrete manhole design as follows:

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1) Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment.

2) Reinforcement: Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design.

3) The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness.

4) Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, and foreign inclusions that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%.

5) Marking and Identification: Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date.

6) Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity.

7) Minimum clearance between wall penetrations and joints shall be per manufacturer's design.

8) Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material, monolithically. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material.

9) Provide resilient connectors conforming to requirements of ASTM C923 or other options as available. All connectors are to be watertight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.

D. See the Pre-Approved Product List (PAPL) for approved Polymer Concrete Manhole Manufacturers.

E. **Manhole Steps**

Manhole steps are reqiured for all manholes. Manhole steps shall be steel reinforced polypropylene. Steps shall have a footing surface at least 10 inches

wide and shall protrude at least 5 inches away from the manhole wall. The step surface shall have a tread plate or other safety surface. Steps shall be provided on 16-inch centers vertically and be located directly below the manhole cover on the eccentric cone section. Steps shall be located directly over the outlet pipe on the base.

See the Pre-Approved Product List (PAPL) for approved manhole step Manufacturers.

F. **Flexible Pipe-to-Manhole Connector**: A flexible Pipe-to-Manhole connector shall be employed in the connection of the sanitary sewer to precast manholes

The connector shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. No adhesives or lubricants shall be employed in the installation of the connector into the manhole. The rubber for the connector shall comply with ASTM C923 *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, and consist of EPDM and elastomers designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

All stainless steel elements of the connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe, which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a breakaway torque wrench available from the precast manhole supplier, and set for 60-70 inch/lbs.

Flexible sleeve boots shall not be used with concrete pipe or on pipe larger than 18 inches in diameter. Boots shall have either a serrated flange of the boot cast into the manhole wall or an expanding stainless steel interlocking sleeve to compress the boot against a cast or core hole (PSX, KOR-N-SEAL or equal) may be used. Mechanical expansion of the interlocking ring shall be done in accordance with the manufacturer's recommendations.

The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

Manhole boots shall be double clamped.

Refer to **Standard Detail 532.01** for boot to pipe connection detail.

G. **Joints at Existing Manholes (Clay Brick and Concrete Brick)**

For 12 inch and smaller pipe, a virgin PVC waterstop concrete manhole adapter (Fernco Joint Sealer Company - CMA series or equal), sized for the respective pipe, shall be placed over the pipe, centered horizontally within the manhole wall and the space between the pipe and manhole completely filled with non-shrink grout (water plug or approved equal).

For 15-inch and larger sewers, the annular space shall be complete filled with nonshrink grout. Standard brick and mortar shall then be place completely around the pipe outside the manhole, supported on the extended base and entirely coated with at least 3/4 inch of mortar. Particular care shall be exercised in placing the

bedding in order to achieve adequate and uniform support of the manhole and the pipe through the first joint outside the manhole.

2.2.19 TRANSITION OR REPAIR COUPLINGS

A. Where it is necessary to join pipe of same type pipe or different types of pipe (e.g. DIP to SDR 35 PVC), a rigid couplings encased in stone shall be used. Couplings shall conform to the applicable provisions of ASTM C1173 *Standard Specification for Flexible Transition Couplings for Underground Piping Systems,* UPC 4224, Corrosion Resistant AISI 304 Series Stainless Steel Click-Lock Clamping System, High Impact Polyamide (Nylon) Securing Cage with an injection molded EPDM rubber sealing gasket. Coupling to be compatible with Clay pipe, Ductile Iron Pipe, Asbestos Cement Pipe, Cast Iron Pipe, Plastic and Concrete pipe.

B. See the Pre-Approved Product List (PAPL) for approved transition or repair coupling Manufacturers.

C. **Poured concrete collars are not permitted**.

D. Fernco couplings are not permitted.

2.2.20 DETECTABLE WARNING TAPE AND COPPER LOCATOR WIRE

A. **Metallic underground warning tape**: Metallic warning tape shall meet ASTM D2103 *Standard Specification for Polyethylene Film and Sheeting*, ASTM D882 *Standard Test Method for Tensile Properties of Thin Plastic Sheeting*, and ASTM D2578 *Standard Test Method for Wetting Tension of Polyethylene and Polypropylene Films.* Tape shall have permenant messaging “SEWER LINE BELOW” repeated along the length of the tape, color coded background that conforms to APWA uniform color code specification (Green for Sewer) with silver and black ink letters, lead free, detectable by conductive and inductive methods, 5 mills overall thickness:, 0.35 mil foil thickness.

A detectable warning tape shall be used with all sewer mains as shown on **Standard Details 531.01** and **531.02**. Underground warning tape is to be placed directly over the pipe 12 to 18 inches above the pipe.

Standard color code for tape and wire.

Green: Sewer Systems

See the Pre-Approved Product List (PAPL) for approved metallic warning tape Manufacturers.

B. **Locator Wire (for Force Mains)**: When ordered by the Engineering Director, place a locator wire meeting the following specification:

1) #12 AWG Blue insulated solid or stranded copper wire, Voltage: 600V rated; XLP/USE-2/RHH/RHW-2, direct bury listed.

2) Electrical conductivity along the pipe shall be continuous and uninterrupted between valve boxes or manholes. Clamps used to bond wire to conductor to metal (in instances where both PVC and ductile iron are used in the same run

of pipe) shall be heavy-duty stainless steel approved by the Engineering Director.

3) See the Pre-Approved Product List (PAPL) for approved locator wire Manufacturers.

2.2.21 RIFD MARKER BALLS WITH iD READ/WRITE

See paragraph **2.2.4 of Specification Section 02275** *Utility Trenching, Backfilling and Compaction of Utilities. See also* **Standard Detail C01.04***.*

2.2.22 WETWELL/VALVE VAULT ACCESS HATCHES

A. **Non-Traffic Areas**

Non-traffic rate aluminum hatches, one-piece aluminum extruded frame with a continuous concrete anchor as part of the one-piece extrusion. Door panels are to have ¼-inch thick aluminum diamond plates to withstand a live load of 300 psf with a 1.5 safety factor. Doors to be provided with SS hinges with tamper-proof fasteners. All hardware is to be stainless steel. Doors to be provided with spring-loaded doors. Doors to open 90 degrees and lock automatically in that position with a stainless steel positive locking arm and a SS release handle. Door to have padlock hasp for doors on wet wells and valve vaults. Doors to close flush with top of frame. Hatches to be equipped with fall protection grating system features meeting OSHA fall protection standards. Vaults in pedestrian areas shall have recessed latch. See **Standard Detail 534.02**.

B. **Traffic Areas** – Vaults not permitted in traffic areas.

C. **Guarantee and Manufacturer**: The aluminum access frames and covers shall carry a 10-year guarantee against defects in materials and workmanship. The frame and cover shall equal or exceed the units manufactured by the following:

See the Pre-Approved Product List (PAPL) for approved wetwell/valve vault access hatch Manufacturers.

2.2.23 YARD FLUSHING HYDRANTS

2-inch yard flushing hydrants shall equal or exceed the Eclipse No. 2 Post Hydrant as manufactured by the Kupferle Foundry Company. See **Standard Detail 514.08**.

PART 3 – EXECUTION

INSTALLATION – PIPE AND FITTINGS

3.1 PIPE AND FITTINGS

3.1.1 CONSTRUCTION – ALL PIPE

A. **Trench width shall be per Standard Detail 531.01**.

B. **Protection of Existing Sewers**: Sewer lines under construction shall be plugged with a mechanical plug at the first manhole upstream from the point of connection. Plug shall be placed in the outlet connection and secured with a steel cable. Plug shall have a tab/label associated with it that has the Contractor's name, phone number, and equipment number. Plug shall remain in place until acceptance of lines by the Town's authorized representative. Water, stone, dirt, or any other debris shall not be allowed to enter the Town's sanitary sewer system during flushing operations or at any other time. Construction taking place in the vicinity of any existing Town sewer lines or manholes shall not cause any inflow of surface water or debris to enter the Town's sanitary sewer system. Existing Town manholes located in construction sites are to remain accessible at all times. The Owner and/or Contractor shall be responsible for any damages incurred to the Town's sanitary sewer system and any fines imposed by NCDEQ, Division of Water Resources due to sewer spills or overflows.

C. **Pipe Laying Direction**: Place piping beginning at low point and progress uphill. Place on grade, with unbroken continuity in invert, horizontally and vertically, and on alignment as indicated on plans. Place bell ends of piping facing upstream. Install gaskets, seals, sleeve, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

D. **Directional changes in gravity lines**: Use manholes for changes in direction of gravity lines.

E. **Handling New Pipe**: Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling. Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

F. **Stringing out Pipe**: Only the amount of pipe that will be used in one day may be strung out. When pipe is strung out, it shall be set on high ground and in a position to prevent silt deposits, storm water, or other matter from entering the pipe prior to its placement in the trench.

G. **Pipe Laying**: The foundation for sewer pipe shall be a firm flat bottom trench with a minimum of 3-inches of compacted stone for gravity sewer mains. The pipe and fittings shall be laid in the trench so that its interior surface shall conform to the grade and alignment as shown on the plans. Pipe laying shall be done in such a way as to disturb as little as possible the pipe that has already been laid. The alignment and grade of the sewer main may be field adjusted whenever, in the opinion of the Town, it is necessary, so long as the adjustments are within that allowed by NCDEQ based on regulations in affect at the time of the change and so long as the changes are consistent with Town's policy in affect at the time of the change. Changes in either grade or alignment may only occur at manholes.

Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter. All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry. Lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory-fabricated joints shall then be placed, fitted, and

adjusted in such workmanlike manner as to obtain the degrees of water tightness required.

Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled. As soon as possible after the joint is made, sufficient bedding material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade. The greatest care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.

All special fittings, such as wyes and other connections, shall be installed at the points indicated on the plans, in accordance with the Standard Detail drawings. Use appropriate adaptors to tie connection pipe to wyes or saddles. Plug end of connection with appropriate plug.

After the trench foundation has been properly graded to receive the pipe, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced.

Any defects due to settlement shall be corrected by the Contractor.

H. **Temporary Suspension of Work**: When the trench is left for the night or if pipe laying is suspended, the upper end of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plug shall be kept in the end of the pipe line at all times when laying is not in actual progress.

I. **Cutting or Fitting Pipe**: Whenever a pipe requires cutting, to fit in the line or to bring it to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe or liner. When the cut end is to be assembled in a *Fastite* bell, an adequately smooth (without sharp edges) bevel should be ground or filed on the cut edge to prevent damage to or dislodgement of the gasket during assembly. The method of cutting pipe shall be in accordance with manufacturer's recommendations. No welding, flame cutting or flame tapping will be allowed. Such cuts shall be made by the Contractor.

J. **Surface Water Crossings**: Surface water crossings (wetlands, floodplains, etc.) with pipe underground shall be ductile iron pipe. Pipe material shall remain constant between manholes. No transition of pipe material between manholes is permitted.

K. **Ravine/Channel Crossings**: Ravine and channel crossings are to be perpendicular to the ravine or channel crossed. Pipe support piers or steel girders, as applicable, shall adequately support surface water crossings with pipe above the water. Asphalt felt paper, or approved equal, isolation barrier shall be placed between pipe and all points of contact with concrete and stainless steel straps. Disturbed banks are to be stabilized with rip rap placed over a non-woven fabric.

L. **Crossing Conflicts**: All drains, gutters, culverts, and sewers for surface drainage are to be kept open or if unavoidably closed, other provisions are to be made for this drainage to the Engineering Director's satisfaction.

3.1.2 DUCTILE IRON PIPE

A. **CONSTRUCTION:**

Gravity DIP shall conform to the same foundation and backfill requirements as those prescribed for water mains. Minimum laying length shall be 18 feet except for tie-in at a structure. However, bury limitations shall govern as follows:

Table 02530.1 Bury Limitations on DIP	
Pipe	**Maximum Bury to Invert of Pipe**
8-inch DIP thru 24 inch Thickness Class 50	18 feet (need Town's approval if bury depth is > 18 feet)

See **Standard Detail 531.01** for sewer DIP laying conditions.

B. **MECHANICAL JOINT BOLT TORQUE:**

Where mechanical joint fittings are required, unless otherwise advised by the manufacturer, the minimum bolt torque shall comply with Table 2 of AWWA C600 for mechanical joints, as follows:

Bolt Size (Inches)	Torque (Ft-Lbs)
5/8	45-60
3/4	75-90
1	100-120
1 1/4	120-150

C. See also 02275 – Trenching, Backfilling, and Compaction of Utilities.

D. Minimum cover shall not be less than 3 feet.

3.1.3 PVC PIPE

A. Installation shall comply with *Underground Installation of Flexible Thermoplastic Sewer Pipe*, ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications* and Uni-PUB-6: *Installation Guide for PVC Solid-Wall Sewer Pipe (4-48 in)*. Installation of PVC Truss Pipe shall comply with ASTM D2680 *Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping,* Appendix XI, or latest revision,

B. **Bury Limitations**:

Table 02530.2 Bury Limitations on all PVC		
Pipe	**Bedding**	**Maximum Bury to top of pipe**
SDR 35 PVC	Class B-1 w/ DOT # 57 or #67 stone	Per Uni-Bell Handbook

Table 02530.2		
Bury Limitations on all PVC		
Pipe	**Bedding**	**Maximum Bury to top of pipe**
PVC C900/C905	Class B-1 w/ DOT #57 or #67 stone	Per Uni-Bell Handbook

Minimum cover shall not be less than 3 feet.

3.1.1 HORIZONTAL DIRECTIONAL DRILLING OF HDPE PIPE FORCE MAINS

A. HDPE pipe shall be installed by Horizontal Directional Drilling (HDD) using a surface mounted rig, first to drill a guided hole along a bore path consisting of a shallow arc and then to pull a string of pipe into the hole. Pull back is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe diameter. Drilling fluids are injected into the bore hole to stabilize the hole and lubricate the pipe and drill-string. Tracking equipment is used to guide and direct the drilling.

1) Mechanical Restraint

When Polyethylene pipe is pressurized, it expands slightly and shortens slightly. Shortening may be enough to disjoin unrestrained mechanical joints that are in line with PE pipe. Disjoining can be prevented by installing external joint restraints at mechanical connections, by installing line anchors, or by a combination of both. Contractor shall install mechanical connections with joint restraint at each connection to mechanical joint pipe.

Note: Poisson Effect pipe shortening must be taken into account whenever the pipe is pressurized, both during the pressure testing, and when it is placed in service. Because pressures are usually higher during pressure testing (up to 150% of the system pressure rating), pipe expansion and Poisson Effect pipe shortening may be slightly greater during pressure testing. Before pressure testing, all mechanical joint restraints must be completely installed and secured per manufacturer's instructions. Concrete in-line anchors and thrust blocking (if used) must be fully cured (minimum of 21 days for 3,000 psi or 7 days for 4,500 psi concrete) and properly backfilled before testing. Restraint is not required at PE to PE butt fusion joints. Restraint is not required at bolted flanged joints.

Mechanical coupling: Stainless steel internal stiffeners shall be used on all couplings to increase the seal. All couplings shall have restraint devices per the manufacturer's recommendation and installed per the Manufacturer's direction.

B. **Installation and Testing**

The Manufacturer shall supply an Installation Manual to Engineering Director, which outlines guidelines for handling, joining, installing, embedding, and testing of the Polyethylene Pipeline. These guidelines shall be used as reference material by Town's Engineer in his determination of the required procedures.

Joints between plain ends of Polyethylene pipe shall be made by butt fusion when possible. The pipe manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the fusion machine manufacturer. The wall thicknesses of the adjoining pipes and fittings shall have the same DR at the point of fusion.

When saddle connections are fusion welded, the Manufacturer's recommended saddle fusion procedures shall be used.

If mechanical fittings (which are designed for or tested and found acceptable for use with Polyethylene pipe) are utilized for transitions between pipe materials, repairs, joining pipe sections, saddle connections, or at other locations; the recommendation of the Mechanical Fitting manufacturer must be followed. These procedures may differ from other pipe materials.

On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, and then fusion test straps shall be cut out. The test strap shall be 12 inches long or 30 times the wall thickness in length (minimum) and 1 inch or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trail fusion shall be made, cooled completely, and tested. Butt fusion of pipe to be installed shall not commence until a trail fusion has passed the bent strap test.

Socket and Straddle fusions shall be tested by a bent strap test as described by the Pipe manufacturer. The pipe manufacturer shall provide visual guidelines for inspecting the butt, saddle, and socket fusion joints.

Pressure testing shall be conducted in accordance with manufacturer's recommended procedure. Pressure testing shall use water as the test media. Pneumatic testing is prohibited.

C. **Shop Drawings**

Contractor shall submit shop drawings and details on the proposed HDPE pipe, fittings, bore methods, etc., for review and approval of Engineering Director before ordering material or beginning installation of the HDPE. Contractor shall also submit to Engineering Director proposed subcontractor's name as well as references on which he/she plans to use on this project. All subcontractors/installers must be approved by Engineering Director.

3.1.4 STEEL PIPE

All operations of the Contractor shall be subordinate to the free and unobstructed use of the right of way of the passage of traffic without delay or danger to life, equipment, or property.

A. **AERIAL PIPE:**

Where required, steel aerial pipe shall meet the length, thickness, and diameter shown on the plans.

Pipe is to be joined by welding. The pipe shall be beveled and prepared for field welding at the circumferential joints. Joining of steel pipe shall meet the

requirements of AWWA C206, *Standards for Field Welding Steel Water Pipe Joints.*

Asphalt felt paper shall be placed between pipe and all points of contact with concrete and stainless steel straps. Upon completion of installation, paint the exterior of the pipe with coal tar enamel. See section 2.1.3 of this specification.

B. **ENCASEMENT PIPE:**

General: Where required, steel encasement pipe shall meet the length as shown on the plans and the thickness and diameter as shown on **Standard Detail C07.01**. Boring across roads and railways shall be performed by dry boring and jacking a steel encasement pipe under the pavement or rail. The encasement shall be located in an area that is relatively free from material such as rock and stone that may hamper the boring operation. If requested by the Engineering Director, the Contractor shall submit a complete plan and schedule for pipe installation prior to the commencement of such work. The submission shall include complete details of the sheeting, shoring and bracing for the protection of the roadbed and the materials and equipment pertinent to the boring operation. The Contractor shall not proceed with the pipe installation until he has received approval of the plan and schedule from the Engineering Director.

Construction shall be executed in such a manner as to prevent settlement of the ground surface above the pipeline. The installation of the pipeline shall follow the heading or tunneling excavation as closely as possible.

All operations of the Contractor shall be subordinate to the free and unobstructed use of the right of way of the passage of traffic without delay or danger to life, equipment, or property. Installation shall be in accordance with of the *NCDOT Standard Specifications for Roads and Bridges, latest revision* or AREA, as applicable.

The pipe shall be plain end, mill beveled for field butt welding, unwrapped steel pipe and prepared for field welding at the circumferential joints. Joining of steel casing pipe shall meet the requirements of AWWA C206, AWWA *Standard for Field Welding of Steel Water Pipe*. Field welded joints shall be performed by AWS D.1.1 certified welders and shall be full penetration single vee groove, butt type welds around the entire circumference of the pipe. The pipe shall be in at least 18-foot lengths. Casing shall be installed by either dry boring and jacking or open cut, as indicated on the drawings.

Encasement ends shall be enclosed as shown on **Standard Detail C07.01**. The steel encasement pipe shall be of leak proof construction. All exposed metal is to be coated with epoxy or asphaltic material.

Encasement ends shall be enclosed as shown on **Standard Detail C07.01.**

Creek Crossings: Sewers crossing creeks shall be encased in a steel casing with concrete anchors placed at each end of steel casing. Depending on clearance from stream bed, Engineering Director may require full concrete encasement of steel casing on sewer lines. Concrete anchors shall be set to provide a minimum of 12 inches of projection beyond the anchor for attachement of end seals. Creek crossings chall conform to **Standard Detail C07.02.**

Manufactured Spiders/Skids for Encasement Pipes: The spiders necessary to support the carrier pipe inside of the steel encasement pipe shall be in accordance with paragraph *2.1.3A 3a, Spiders/Skids for Encasement Pipes*. Unless otherwise shown on the drawings, one spider shall be placed at each bell end and one at each end of the encasement pipe (see **Standard Detail C07.01** for location of spiders).

All carrier piping shall be mechancial joint ductile iron pipe with restraint gland.

3.2 TUNNELING METHOD

A. **GENERAL**:

1) The contractor shall submit shop drawings to Engineering Director for approval prior to construction. All liner plates and ribs used in the tunnel shall be of one type. All material removed shall be disposed of off the site by the Contractor.

2) All operations of the Contractor shall be subordinate to the free and unobstructed use of the rights of way for passage of traffic without delay or danger to life, equipment, or property. The Contractor shall provide all necessary bracing, bulkheads, and shields to ensure safety to traffic at all times. The Contractor shall provide all traffic control devices as necessary and as shown on the approved traffic control plan at no additional cost.

B. **TUNNELING (BORING METHOD):**

1) Commence boring operation from a pit, with the bottom excavated to grade, and sheeted or shored if necessary. A steel pipe shall be jacked in place as a casing pipe. Boring through rock shall be oversized to allow installation of carrier pipe but no casing pipe shall be required unless liner plate is necessary for safety reasons.

2) Smoothly pave the bottom of the tunnel with concrete. Pull the carrier pipe in place a joint at a time. Securely block each section in place.

C. **TUNNELING (HAND MINING):**

1) Commence tunneling operation from a pit, with the bottom excavated to grade, and sheeted or shored if necessary.

2) All blasting shall conform to requirements for blasting in *02275 – Trenching, Backfilling and Compaction of Utilities*.

3) Install the steel liner plates immediately after the excavated material has been removed, and remove the material not more than 24 inches ahead of the installed liner plates.

4) Grout all voids between the soil and tunnel liner plates. The maximum grouting pressure shall be 30 psi. Start grouting at the bottom of the tunnel liner plates and proceed upward progressively and simultaneously on both sides of the tunnel. Install liner plates no more than 6 feet ahead of grout section. Prohibit traffic over ungrouted sections of tunnel unless this section is in solid rock. Thoroughly dry-mix grout ingredients before adding

water. After adding water, mix the batch for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. Placing shall be quick and continuous. Placement shall be under pressure with a grout pump. The period between installation of the tunnel liner plate and the placing of grout shall not exceed 7 hours, without the approval of the Town. Upon completion of grouting, fill grout plugs with provided grout hole plugs.

A pump shall be provided for placing the grout which shall be capable of exerting sufficient pressure to assure the filling of all voids between the liner plate and the undisturbed ground. Minimum acceptable pressure to fill voids will be 5 psi. The maximum grouting pressure shall be 30 psi.

Pumping of grout shall be done:

i. At the completion of the installation of approximately each 6-foot of liner plate,
ii. At more frequent intervals than 6-foot if conditions indicate the necessity, and
iii. At the end of a work shift or for stopping of work for any reason.

5) Smoothly pave the bottom of the tunnel with concrete. After installation of the tunnel liner plates, the Contractor shall pour concrete pavement on the bottom quadrant (invert) of the tunnel, the surface of the pavement being parallel to the inner plate, with screed rails embedded in it, on line and grade for the installation of pipe in the tunnel.

6) The periphery of the tunnel shall be trimmed smooth to fit the outside of the steel liner plate as nearly as is practical, so that the void outside the plates is a minimum.

7) After installation of the tunnel liner, pull the carrier pipe in place a joint at a time. Securely block each section in place. Each joint of the carrier pipe shall be supported at two points by steel saddles or by steel spiders, strapped to the carrier pipe with steel straps. The carrier pipe shall be blocked, in place to the prevent flotation.

8) Close up tunnel liner ends to protect against entrance or foreign matter. The open ends of the casing pipe or tunnel shall be closed off by an 8-inch grout or masonry block wall prior to backfilling. A steel drain line to a 1 cubic yard French drain or to daylight shall be provided.

9) If installation is under railway tracks, all permits shall be obtained and Railway Company shall be notified prior to such installation. The same shall apply to contacting the applicable Municipality or NCDOT if installation is under a roadway.

D. See also **PART 2 – PRODUCTS**, Section 2.1.4, "*Tunnel Liners and Appurtenances."*

3.3 MANHOLE CONSTRUCTION

A. **Standard Manholes:** Manholes shall be constructed in accordance with **Standard Details 532.01, 532.02, 532.03, 532.07** and **532.10**. The Contractor shall exercise care in the ordering of manholes so that the use of grade rings for leveling and

adjustments can be minimized. External sealing systems are to be placed on the buried exterior joints of manholes.

1) **Standard Manholes**: Standard manholes shall be those greater than 5 feet in depth measured from the base of the cover frame to the top of the concrete footing.

2) **Shallow manholes**: shallow manholes shall be 5 feet or less in depth measured from the base of the cover frame to the top of the concrete footing and shall be of the flat top construction (eccentric opening) and shall be capable of supporting HS-20 traffic loading.

Non-shrink grout shall be placed around pipe where pipe meets precast invert in manhole to provide for a smooth transition for sewage flow.

Manholes shall be installed plumb.

In the case of either integrally cast or expanding sleeve boots, the pipe exterior and boot interior shall be thoroughly lubricated prior to pipe insertion. The exterior of the boot under the bands shall be thoroughly lubricated with pipe soap. Puckering of boots shall not be allowed.

Flexible sleeve boots shall not be used with concrete pipe or on pipe larger than 18 inches in diameter. Boots shall be double banded.

When applicable, during installation of manhole, if frame and cover is near or within wheel path in roadway, turn cone to place out of wheel path.

B. **Drop Manholes:**

Interior drop manholes shall be installed per **Standard Detail 532.09**. Interior drop connections on new manholes shall consist of C900 PVC pipe and joint fittings. Interior drop connections on existing manholes shall be in accordance with **Standard Detail 532.09**. Interior drops are permitted on existing 4-foot diameter manholes.

Manholes shall conform to paragraph 2.2.17, Precast Reinforced Concrete Structures. See also paragraph 2.2.14 for Manhole Inside Drop Bowls.

C. **Flexible Pipe-to-Manhole Connector**: When it is necessary to field core a manhole and install a flexible Pipe-to-Manhole connector in precast concrete sanitary sewer manholes, the connector shall be installed per the manufacturer's recommendations.

D. **Precast Concrete Doghouse Manholes**: When it is necessary to install a manhole over an existing sewer main, a precast concrete doghouse manhole shall be installed over the main. A minimum of an 8-inch thick reinforced concrete base shall be poured over a #57 stone base and the doghouse manhole risers set over the existing sewer. The joint between the precast manhole and the base shall be sealed both inside and out with grout. The annular space of the precast manhole, around the main, shall be filled with grout and a shelf formed to the springline of the existing main. The crown/top of the main shall be removed once the shelf has been formed and has set sufficiently and all upstream lines tested and approved by the Town. See **Standard Detail 532.05**.

E. **Manhole Inverts**:

Manhole inverts may be formed from brick and/or 3000 psi concrete and shall be constructed a shown on **Standard Details 532.01, 532.02, 532.03, 532.05,** and **532.0**7. The depth of the channel shall be 3/4 of the pipe ID with vertical wall from the springline of the pipe up. The bench shall then be sloped to the manhole walls at ½ inch per foot. The channel shall be "U" shaped. Curved channels due to changes in pipe alignment shall be constructed in such a way as to provide gentle curves as shown on **Standard Detail 532.01**.

The internal cavity between the boot and the manhole wall will be completely filled with non-shrink grout and filleted at the manhole wall. The face where the pipe enters or leaves the manhole shall be struck smooth and the channel shall form a smooth flow line from the pipe entry to pipe exit.

F. **Installation of Manhole frames and Covers**: Frames and covers (**Standard Details C06.01** and **C06.02)** shall be installed to manhole in accordance with **Standard Detail 532.03**. Frame and covers shall be installed to finished elevation. Adjustments shall be made as necessary to achieve finished elevation. On all manholes, a butyl rubber (mastic) sealant shall be applied to the top of the concrete cone section or grade adjustment ring. Frames & covers are to be bolted to the manhole cone.

G. **Manhole Steps:** Steps **(Standard Detail C06.04)** are to be located over the outlet pipe. Steps shall be firmly anchored in the riser/cone/base sections by the precast manhole manufacturer.

H. **Grade Rings/Adjustments**: In street rehabilitation work, the combination of grade rings and/or clay brick/concrete block shall not exceed 2 rings before removal of the cone is necessary to effect adjustment. Metal grade ring risers are not permitted. See **Standard Detail C06.03**.

I. **Replacement/Rehabilitation of Existing Manholes:**

Replacement of manholes: The Town reserves the right to require replacement of the existing manhole with a new manhole. The Town will provide the manhole but the Contractor shall pick up and install it. When a new manhole is necessary, the old manhole must be completely removed and a new precast manhole constructed in its place.

Any tie-in's performed on sanitary sewer manholes must be machine-core drilled with a neoprene flexible boot and adjustable band, except brick manholes. The core shall be the size specified with a smooth finish. If connecting to existing brick manhole, seal penetration and add "Strong-Seal" on perimeter of manhole. Coordinate with the Town.

J. **Connection to Existing Manholes**

Connection to existing sewer shall be made at manholes. For connection of encased pipe, the casing shall be flush with the inside wall and shall be encased with at least 8 inches of stone on the outside of the manhole. Existing manholes to which connections are made shall be rehabilitated, as directed by the Engineering Director, to the degree necessary to correct any apparent signs of

infiltration or inflow (see paragraph 3.3 I, *Replacement/Rehabilitation of Existing Manholes*).

Upon completion of the connection to existing sewers, existing lines no longer needed shall be sealed or plugged and the invert rebuilt to reflect the new flow patterns.

K. **Testing of New Manholes**: Manholes are to be subjected to a vacuum test. Manholes shall be vacuum tested after installation in accordance with the manhole vacuum testing procedures outlined in Section 3.9, paragraph B, item 9. Service connections tied into manholes shall be tested in conjunction with the manhole.

3.4 ABANDONING SEWER LINES & MANHOLES

A. **Sewer lines**: When an existing sewer line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout (flowable fill) pumped into the line until it is completely filled.

B. **Manholes**: When an existing manhole, either partially or wholly, is designated to be abandoned and the sewer lines, either entering or exiting the manhole, have been abandoned according to the preceding paragraph, the upper portion of the manhole is to be removed to within 36 inches of the proposed finished grade, or as determined by the Engineering Director. Below pavement, backfill with flowable fill concrete. Outside of pavement, backfill with select fill compacted in place.

3.5 CONNECTION TO EXISTING SEWERS

Where required or shown on the plans, connection to existing sewer shall be made in a manner that will maintain existing sewage flow on a continuous basis. Where flow cannot be maintained, interruption of service shall be minimized such that no by-pass of sanitary sewage to any natural waterway or storm drain occurs nor shall such interruption create a public health hazard by sewage back up or overflows. Sewage by-pass pumping shall comply with the requirements of paragraph 3.6, *Bypass Pumping*, below.

Connection to existing sewer mains shall be made at manholes. See paragraph 3.3 J, *Connection to Existing Manholes*.

3.6 BYPASS PUMPING

A. The bypass system shall be of sufficient capacity to handle peak flow of the pipe. Provide the necessary labor and supervision to set up and operate the pumping and bypassing system. A redundant or back-up system of (2) two pumps shall be utilized. A single pump scenario is not permitted.

Contractor shall comply with local Town sound ordinance. If pumping is required between the hours of 8:00 PM and 6:00 AM, engines shall be equipped as specified in paragraph E, below, in order to keep noise to a minimum. **The equipment shall be manned continuously**. During bypass pumping operations, the Contractor shall provide the necessary labor to continually monitor the operation and ensure uninterrupted and sufficient pumping at all times.

B. Contractor shall provide all materials and labor as necessary to maintain flows in the existing sewer interceptor and all collector and lateral lines at all times and under all weather conditions. Interruption of flows will not be permitted. Overflows

from bypass operations will not be permitted to enter into any streams or bodies of water. **The Contractor will be solely responsible for any legal actions taken by the state regulatory agencies if such overflows occur during construction.**

C. Bypass pumping equipment shall include pumps, conduits, engines, and related equipment necessary to divert the flow or sewage around the section in which work is to be performed. In addition, the Contactor shall maintain at the same location and in operable condition, duplicate equipment to be used in case there is equipment failure. In this event, the Contractor shall promptly repair or replace the failed equipment to the satisfaction of the Engineering Director.

D. The new sewer line may be used by the Contractor to carry the sanitary flows after the new pipe has passed inspection and testing. Any "temporary" connections to the new sewer line shall be approved by the Town.

E. Engine driven equipment for bypass pumping equipment shall have "critical grade mufflers." If equipment is operated between the hours of 8:00 PM and 6:00 AM, this equipment shall also be provided with sound attenuation enclosure consisting of a three sided enclosure with roof constructed of 2 x 4 frame with ½-inch plywood sheathing and 2-inch Styrofoam panels attached to the inside of the entire enclosure. The enclosure shall be portable in order to allow the enclosure to be moved when bypass pumping equipment is moved. These conditions are subject to any other additional stipulations that may be required by local Town sound ordinances.

F. **Plan Requirements**: The plan should include, but is not necessarily limited to, the following details:

1) Staging areas for the pumps.
2) Sewer plug method and type of plugs or gates to be used.
3) Number, size, material, locations, and method of installation of suction piping.
4) Bypass pump sizes, capacity, number of each size to be on site, and power requirements.
5) Calculations of static lift, friction loss, and flow velocity.
6) Stand-by power.
7) Downstream discharge plan.
8) Method of noise control for each pump.
9) Temporary pipe supports and anchoring required.
10) Heavy equipment needed for installation of pumps and piping.
11) Stand-by/back-up pumpset for the bypass application.
12) Detail plan for 24-hour monitoring.
13) Fueling of pumpsets on demand.

G. **Sewer Overflows – Penalties**: The Contractor shall make every effort to avoid causing sewer overflows. All sewer overflows shall result in the following disciplinary actions:

Incident	Penalty
First Violation	$2,000
Second Violation	$5,000
Third Violation	$10,000

Fourth Violation	Termination of Contract

For all sewer overflows, the Contractor shall be responsible, and shall reimburse the Town, for any damages, operational costs, fines, civil penalties, or other effects.

1) **Unplanned Service Outages**: The Contractor shall make every effort to avoid causing unplanned service outages. All Contractor caused service outages shall be investigated by the Engineering Director. If the investigation determines that the Contractor could have avoided the service outage, then the outage shall result in disciplinary action as shown above.

3.7 SERVICE CONNECTIONS

A. **New Services**: Unless otherwise permitted by the Engineering Director, all sewer services shall be PVC Schedule 40 pipe solvent cement joint pipe and fittings. The laying and joining of service connection pipe shall conform to the same requirements as stipulated for main installation. Sewer services are to be connected to main except at manholes on cul-de-sacs. When connecting to manholes, services are to come in at the bottom of the manhole. See **Standard Detail 533.01**

Any service with a bury depth greater than 12 feet shall be Protecto 401 Ceramic Epoxy lined DIP or C-900 PVC, as directed by the Engineering Director.

B. **Location of Service**: Unless directed otherwise by the Engineering Director, service connections shall extend to a point within the right-of-way or easement. In streets with curb and gutter, the preferred location is 6 inches inside the right-of-way. Service connections shall not be located in driveways or the street unless the clean-out is enclosed in a cast iron box (see **Standard Detail 533.01**). The cleanout is to be set 2 inches below the bottom of the valve box cap in paved applications.

In commercial yard applications, terminate service with a brass plug and set a 24" diameter precast concrete donut above cleanout. See also **Standard Detail; 513.03**.

C. **Bored Services**: Where laterals are bored, the face of the bore cut shall be a minimum distance of five feet from the edge of the pavement on either side unless the Town's Engineering Director gives approval to the contrary.

D. **Service Connections**: 6-inch service connection shall be made at manholes only using cored flexible rubber boot. 4-inch sewer laterals shall be connected to new mains by means of an in-line monolithic wye or, if on an existing line, with a tap and saddle installed over a hole cut in the top quadrant of the main at an angle of 45 degrees, see **Standard Details 533.01** (and **533.02** if permitted by the Engineering Director), with respect to flow direction. The hole shall be cut with a mechanical circular type saw cutter designed for the particular use and rendering a smooth uniform cut with no damage to the main and is one that retrieves the plug. Saddle service "coupon" shall be given to the Town's Inspector for review and approval. Service saddles shall be fully encased with #57 stone and special attention shall be given to embedment of the service pipe from the saddle through

the lateral trench. The cost for such cut-ins shall be included in the cost of the lateral.

Service Saddles: Service saddles shall be constructed using sewer service saddles (see paragraph 2.1.2.F) placed in the top quadrant of the pipe main. Backfill under and around saddle with #57 stone. See **Standard Detail 533.02**. The cost for such cut-ins shall be included in the cost of the lateral.

Use of saddles for service connections (**Standard Detail 533.02**) shall be approved by the Engineering Director on a case-by-case basis.

A cleanout shall be installed at the terminal end of the service connection as shown on **Standard Detail 533.01**. Both the cleanout and the service material shall be capped or plugged to exclude entry of water or earth. Bronze plugs or caps shall be required for all above ground piping. All laterals are to be left exposed until the Inspectors can verify the installation of each service. Set a precast concrete collar on top of all commercial cleanouts in yard applications.

E. **Service Connection to Manholes**: Unless approved otherwise by the Engineering Director, services connections to manholes shall be made at dead end lines only. Service connections must enter the bottom of the manhole whenever possible. If not practical, services may be located above the bottom but may not enter the cone or it's joint. In this type connection, the service is to utilize an inside fiberglass drop bowl (see paragraph 2.2.14 for drop bowl spec and **Standard Detail 532.09**). Drop stack pipes are to be securely attached to manhole walls with a minimum of 1 stainless steel pipe bracket on all drops. Drop stack pipes greater than 5 feet (difference between invert in and invert out) to be securely attached to the manhole wall at 18-inch intervals. Service connections in manholes shall also be core bored and booted and shall be separated by a minimum of 2 times the pipe OD (either vertically or horizontally) from other services or mains. When connections are made at deep manholes, a standard drop connection shall be provided. The invert of manhole service connections shall be located such that a pipe half-diameter channel formed through the bench shall be required. See **Standard Detail 532.09**.

F. **Deep Sewer Service Connections**: For service connection to a deep sewer with confined trenches, the service shall extend from the main service wye connection upward at a 45-degree angle to a point near the trench wall. The riser shall then extend upward, parallel the vertical trench wall, to a point where a combination of bend(s) and a nipple section will provide a turn to the horizontal; providing a minimum pipe bury of 36 inches below finished grade. However, the depth of the service is to be of sufficient depth to provide a service lateral that meets the minimum requirements of the NC State Plumbing Code. Vertical stacks or standpipe services are not allowed. See sheet 2 of 4 of **Standard Detail 533.01**.

G. **Cleanout Location**: The cleanout shall be located 6 inches inside the right of way or easement line. The cleanout is to be set 2' above final grade. See **Standard Detail 533.01**.

A cleanout mini-manhole frame and cover shall be set over the cleanouts located in pavement and in driveways. See sheet 1 of 1 of **Standard Detail 533.01**. the Pre-Approved Product List, *Manhole Frame and Cove*r for approved mini-manhole manufacturers and model numbers. See sheet 4 of 4 of **Standard Detail 533.01** for a cleanout located in easements.

Service connections shall not be located in driveways unless the cleanout is enclosed in a cast iron box (see **Standard Detail 533.01**) with the word "sewer" on the lid. The cleanout is to be set 2 inches below the bottom of the valve box lid. Cleanouts shall not be relocated outside of a driveway once installed.

H. **Final Cleanout Grade Adjustment**: The Plumber shall cut the riser to final grade at time of connection. For Commercial yard applications, a 24" diameter precast concrete collar shall be set over the cleanout at finished grade. See **Standard Detail 533.01**.

I. **Cleanout Spacing:** Unless otherwise shown on the plans, cleanout spacing on either 4- or 6-inch service lines shall not exceed 75 feet on center. Cleanouts shall be provided at all horizontal or vertical changes in direction.

J. **Grade**: Minimum grade for services shall be ¼-inch per foot for 4-inch services. Minimum grade for 6-inch services are to be laid preferably at a 1/8-inch per foot, but no less than 0.6%.

K. During service installation or line rehabilitation on existing mains, the Contractor shall be responsible for the maintenance of all sewer house connections and the proper treatment and/or by-pass of effluent sewer around work areas.

L. Any services or utilities damaged by the Contractor shall be properly repaired.

M. Sewer lines shall be **air tested** (low-pressure air test) after the complete installation of all sewer services. Laterals shall be tested with the main line.

N. **Residential & Commercial Services – A Note to Developers/Contractors:** Unless otherwise approved by the Engineering Director, Residential and Commercial water and sewer services should be installed together per **Standard Detail C07.03.**

3.8 CONCRETE ENCASEMENTS

All concrete encasements shown on the plans shall be constructed per **Standard Detail C07.02**.

The earth may be used for side and bottom forms provided such sides can be excavated uniformly smooth and to the size and shape specified. Care must be taken during the pouring operation to ensure that the pipe does not float or move from the buoyant effects of the concrete. Misalignments of the crossings shall be cause for total removal and replacement of the encasement by the Contractor.

Once the concrete is set, measures shall be taken to cure the concrete by covering it with plastic. Water shall not be allowed to run over the concrete for at least 48 hours.

Forms will be required if the subgrade and sides are not firm, or will not hold shape.

Exercise care to avoid spilling concrete into creek.

3.9 TESTING

A. The following tests shall apply for the respective pipe materials as required by the following specifications.

Table 02530.3
Table of Testing Applications

Material	Air Test	Vacuum Test	Mandrel Test	TV Inspection[b]
All PVC pipe,	X		X	X
HDD PE Pipe[a]	-	-	-	X
DIP	X			X
Manholes		X		

[a]Engineering Director may require a hydrostatic pressure test (either outside the trench or in the trench) per PPI Technical Report TR-31 by the Plastic Pipe Institute.
[b]See Section 3.9 *Testing*, paragraph B.10) *Televising of Sanitary Sewers* for CCTV inspection requirements.

B. **TEST AND INSPECTION:**

Unless otherwise specified (see paragraph 1.11.1 B2c), all sanitary sewer pipe shall be tested after backfilling has been completed and before final acceptance by the Town. Upon completion of entire pipe installation, the Town shall inspect the work in part or as a whole and make such tests as necessary to verify that the work has been carried out in accordance with the plans and specifications.

All manholes shall be of the specified size, shape, and material, and shall have their tops set to the grade as furnished by the Design Engineer.

The Contractor shall provide all equipment, material, water, labor, etc. needed to perform any and all tests in accordance with the procedures listed herein. All equipment, materials, etc. used shall be checked and approved by the Town prior to its use. It shall be the responsibility of the Contractor to ensure pipe to be tested is clean before any tests are made.

1) **General Requirements**: Testing and inspection shall promptly follow installation of wastewater pipe including services. Testing shall not be more than 1000 feet behind sewer pipe laying operation.

   Furnish all pumps, gauges, instruments, test equipment and personnel required for inspections and testing operations.

   All final testing and inspections shall be performed in the presence of the Town's authorized representative.

   Flush all sand, dirt and debris from lines prior to inspection. Provide lights and mirrors and inspect lines in presence of the Town's authorized representative.

   Clean and pretest prior to notifying the Town and arranging for inspections and tests.

   Inspect the system for conformance with line and grade shown on the plans and provide record drawing measurements on Record Drawings.

2) **Flushing**: If during any of the inspections sewer lines and manholes are found to contain mud and other debris, the Contractor shall be required to flush or clean this material from the system by whatever means necessary. Mud and other debris shall not be allowed to enter the existing sanitary sewer system or contaminate or jeopardize flow of any downstream facilities. The Contractor shall be responsible for the cost of water used to flush the system.

3) **Backfill Testing**: Testing of backfill shall be performed in accordance with the requirements of *02275 – Trenching, Backfilling, and Compaction of Utilities*.

4) **Frequency**: Test frequency shall be one test per road crossing and/or per 1000 feet of line except where additional tests are required to determine the extent of unacceptable compaction. These additional tests are the responsibility of the Contractor.

5) **Visual Inspection**: Visual inspections are required by the Town for the Contactors to visually inspect the sewer line from every manhole. All new and/or replaced sewer lines shall be visually inspected (from every manhole) by CCTV. CCTV video shall be provided to the Town. The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines, which do not exhibit a true line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the sewer barrel left clean for its entire length.

6) **Pipe Deflection Test**: Deflection testing shall be performed for all semi-rigid and flexible pipe 8 inches or larger. Deflection shall not exceed 5% (95% of the ASTM base inside diameter). Testing shall be conducted in the presence of the Town's authorized representative and shall utilize a mandrel go/no-go gauge complete with proving ring. Mandrel shall be approved by the Town prior to its use. Arm mandrels shall have a minimum of 9 arms.

   The mandrel device shall be cylindrical in shape and constructed with a minimum of nine evenly spaced arms or prongs. Mandrels with less than nine arms will not be approved for use. The "D" mandrel dimension shall carry a tolerance of plus or minus 0.01 inch. Allowance for piping wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the "D" dimension but shall be counted in as a part of the 5% or lesser deflection allowance.

   The mandrel shall be hand pulled through by the Contractor in the presence of the Town's authorized representative. Any sections of the sewer not passing the mandrel shall be uncovered and the Contractor shall re-round or replace the sewer to the satisfaction of the Town's authorized representative. The repaired section shall be retested.

   The inspection shall be conducted no earlier than 30 days after reaching final trench backfill grade.

   Contact length shall be measured between points of contact of the mandrel arm.

The inspector shall be responsible for approving the mandrel. Proving rings may be used to assist in this. Drawings of the mandrel with complete dimensions shall be furnished by the Contractor to the Town for each diameter and specification of pipe.

7) **Primary test method – Low Pressure Air Test**: Sewer lines shall be **air tested** after the complete installation of all sewer services. Sewer laterals are to be tested along with main. The Contractor shall be responsible for furnishing all equipment and labor for the low pressure air test at no additional cost to the Town.

The portion of the line being tested shall be accepted if the portion under the test meets or exceeds the requirements of ASTM F1417, *Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air*. This requirement shall be accomplished by performing the test as follows: the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig greater than the average back pressure of any groundwater that may be over the pipe shall not be less than the time shown for the given diameters in Table I *Line Pressure Air Test Table.* If the system does not meet the foregoing requirements, the Contractor will be required to locate and repair the leaks at no cost to the Town and repeat the tests until the allowable leakage is obtained.

Procedure:

It is imperative that proper plugs be installed on the laterals at the cleanout stack. All plugs should be properly installed to withstand the test pressures without requiring external bracing or blocking. Before tests are made, all wyes, tees, or end of side sewer stubs shall be plugged with flexible-joint caps, or acceptable alternate, securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible-jointed lateral connection or extension.

Air leakage testing of installed system shall be performed with a continuous monitoring gauge no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of plus or minus 0.04 psi. All air used shall pass through a single, above ground control panel visible to the Town.

All air used shall pass through a single control panel. Individual air hoses shall be used from control panel to pneumatic plugs, from control panel to sealed line for introducing low pressure air, and from sealed line to control panel for continually monitoring the air pressure rise in the sealed line. After all pipes are cleaned, air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches 4.0 psig (greater than average groundwater backpressure that may submerge the pipe). Throttle the air supply to maintain that constant pressure for at least 2 minutes. The air pressure supply shall then be disconnected from the system or shut-off. Do not enter manhole during test. Do not exceed 9.0 psig in the system.

Observe the continuous monitoring gauge while decreasing the pressure to no less than 3.5 psig (greater than groundwater pressure). At a reading of 3.5 (adjusted), or any convenient observed pressure reading between

3.5 and 4.0 psig (adjusted), timing shall commence with a stopwatch or other timing device that is at least 99.8% accurate. Regulate the pressure for at least 2 minutes to permit the air/ground temperature to reach equilibrium before commencing test.

Measure the time interval for pressure to drop 1.0 psig.

If the time, shown in Table I for the designated line size and length, elapses before the air pressure drops 1.0 psig, the section undergoing the test may be discontinued once the prescribed time has elapsed even though the 1.0-psig drop has not occurred. Record all readings.

If the pressure drops 1.0 psig before the appropriate time shown in Table I has elapsed, the air loss rate shall be considered excessive, and the section of pipe has failed the test. Record all readings.

If service lateral sewers are included in the test section, their lengths may be ignored for computing the required test times. The test will be slightly more severe. In the event a test section, having a total surface area less than 625 square feet, fails to pass the air test when lateral sewers have been ignored, the test time shall be recomputed to include all lateral.

If the sections fail the air test, the Contractor shall determine the source or sources of leakage and shall repair or replace all defective material and workmanship. No sealant shall be used in the newly installed sewers to correct the leaks.

The extent and type of repair that may be allowed shall be subject to the approval of the Town. The repaired pipe installation shall be retested and required to meet the requirements of this test.

Safety Note: The air pressure test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. A force of 250 lbs. is exerted on an 8-inch plug by an internal pressure of 5 psi. It should therefore be realized that sudden expulsion of a poorly installed plug, or a plug that is partially deflated before the pressure is released, can be dangerous. As a safety precaution, pressurizing equipment should include a pressure regulator set at, for example, 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. **No one shall be permitted in the manholes during testing**.

TABLE I
Line Pressure Air Test Using Low-Pressure Air
SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015
(Excerpted from ASTM F 1417)

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length For Minimum Time (ft.)	4 Time For Longer Length (sec.)	Specification Time for Length (L) Shown (min:sec)							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33

8) **Infiltration/Exfiltration Testing**

Infiltration/Exfiltration Testing shall be required in addition to the air test for the sewer mains if water is encountered during pipe laying conditions. Infiltration/Exfiltration shall be kept to a minimum amount as possible. All lines not conforming to these specifications shall be rejected by the Town.

Manholes shall show absolutely no evidence of leakage through the walls or bottom.

Determining Which Test to Use: If groundwater is 4 feet above top of pipe, use infiltration test. If groundwater is less than 4 feet above top of pipe, fill pipe and upstream manhole to produce a minimum 4-foot head over the top of pipe, let stand for 12 hours, refill manhole to original level, and conduct Exfiltration test for 1 hour. If the leakage exceeds the specified amount, satisfactory corrections shall be made to the sewer system. Retest as necessary until all tests are returned satisfactory.

Infiltration Test: No infiltration tests will be made until normal infiltration conditions are established. Test shall be made before connections are made to existing sewers and shall be measured by means of a V-notch weir inserted into the line at a manhole of built in a manhole. Tests will not be allowed until all service lines are installed. These tests will determine the correct rates of ground water infiltration. Weir measurements shall be taken at points designated by the Town along the completed pipelines, and at least one measurement shall be made for each 5,000 LF of pipe. Tests shall be made in the presence of the Town's authorized representative. When infiltration occurs in excess of the specified amounts, defective pipe or joints shall be located and repaired. If the defective portions cannot be so located, the original work shall be removed and reconstructed as necessary to obtain a sewer within the allowable infiltration limits upon retesting.

Exfiltration Test: Where lines are above the groundwater table, exfiltration testing will be required. Also, for lines that may be seasonally below the groundwater table or flood levels, but due to dry conditions, upon completion of construction under normal infiltration conditions are not present, the exfiltration tests may be conducted in lieu of infiltration tests.

Infiltration/Exfiltration Limits: Infiltration shall be measured by the Contractor in the presence of the Engineering Director or his representative and shall not exceed 50 gallons per inch diameter per mile per day for pipe diameter larger than 18 inches. For exposed or aerial piping and pipe diameters 18 inches and smaller, there shall be no visible signs of infiltration. Infiltration and exfiltration testing of the lines in lieu of air testing **shall not be accepted** without written approval of the Engineering Director. For these methods to be considered, the Contractor shall state, **in writing**, the reasons for this consideration.

9) **Manhole Vacuum Testing**

All manholes, including doghouse manholes, shall be vacuum tested as indicated below unless otherwise allowed by the Town. Vacuum testing

shall meet ASTM C1244 *Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.* Only new manholes are to be vacuum tested. Vacuum testing of existing manholes is not required.

The test shall be made using an inflatable compression band, vacuum pump, and appurtenances specifically designed for vacuum testing manholes. Equipment to be manufactured by Peter A Glazier & Associates, Worcester, MA or approved equal. The Contractor shall be responsible for furnishing all equipment and labor for the vacuum test at no additional cost to the Town.

Manholes may be tested by vacuum test immediately after assembly of the manhole, frames and connecting pipes, and before any backfill is placed around the manholes. However, the final test and acceptance shall be based only upon a test after the manhole is backfilled and the cover frame castings are grouted in place.

All lift holes shall be plugged with nonshrink grout and all pipes shall be plugged, taking care to securely brace the plugs and pipe. Stubouts, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn.

Manholes shall be tested from the top of the casting, including the casting-to-cone joint (adjusting ring).

Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.

After the testing equipment is in place, a measured vacuum of 10 inches of mercury (Hg) shall be established in the manhole. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. See Table II, *Vacuum Test Table for Manholes*.

If the manhole fails the test, the Contractor shall locate the leakage, make the proper repairs, and the vacuum test shall be repeated until the manhole passes the test. After the manholes have been backfilled and the cover frame casting sealed in place, and prior to final acceptance of the project, any signs of leaks or weeping visible from the inside of the manhole shall be repaired and the manhole made watertight and tested. The extent and type of repairs that may be allowed shall be subject to the approval of the Town. Leaks shall be repaired on the outside of the manhole unless approved otherwise by the Town.

If a manhole joint mastic material is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

10) **Televising of Sanitary Sewers**

CCTV Inspection: It shall be mandatory for the contractor/developer to provide CCTV inspection footage of all new and/or replaced gravity sewer mains as part of the testing and acceptance requirements by the Town. CCTV inspections shall be performed following placement and compaction of backfill and after the placement of asphalt. All expenses reqiured to perform CCTV inspections shall be the sole responsibility of the contractor and/or developer. The Town will incur no cost, at no time, for these inspections.

The Contractor will TV the sanitary sewer gravity lines using a TV inspection truck and all services inspected using a mini-cam. It is the responsibility of the contractor to flush all sand, dirt, and debris from the lines and manholes to ensure there is no sediment or debris in the lines and manholes at the time of the TV inspection. The contractor and/or Engineer or their designated representative shall be present during the TV inspection. Contractor to provide a minimum 24 hours' notice to the City's representative prior to TV inspection. Alternatively, when the Engineering Director permits, contractors may TV their lines and deliver the TV inspection and log on CD or flash drive to the Town for review. Regardless of whether the Town's representative is present or not during TV inspection, a CD or flash drive log of the inspection is required to be delivered to the Town's representative upon completion of all TV inspections and within a week of televising. Once submitted, the Town will have 10 business days to review the media and provide comment to the contractor/developer as to any issues or acceptance.

Inspection Criteria:

a. The lines will be checked for leaking joints, deformed pipe, cracked pipe, grade problems, excessive infiltration, and overall appearance.

b. TV inspections are required at completion of other required testing and following placement of stone base but prior to placement of pavement.

The Contractor will televise all gravity sewer lines for conformance to the project drawings and specifications. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the Towny; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.

The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the line's condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the gravity sewer line conditions shall be used to move the camera through the gravity sewer line. If, during the inspection operation, the television camera will not pass

through the entire manhole section, the Contractor shall set up his equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire manhole section, the inspection shall be considered complete and no additional inspection will be required.

In the event the CCTV inspection is deemed to be unsatisfactory by the Town, the contractor/developer shall solely be responsible to resubmit the footage until deemed acceptable by the Town.

The Town may also televise storm drainage lines prior to the expiration of the one-year warranty. If a defective condition is found, it shall be presumed to be caused by defective workmanship or materials. The Contractor shall be notified and shall correct the work in a manner approved by the Town.

11) **Force mains**

a. **Order of Operations**: Except for chlorination and tests for purity, the installation of sewer force mains shall be set forth on the plans and shall meet the requirements for water mains and as set forth in these specifications. Fill the system with water at a velocity of approximately 1 foot per second while necessary measures are taken to eliminate all air. Do not leave fill line connected to sewer line unless an RPZ backflow preventer is placed between the potable water supply and the line being filled. At the Contractor's expense, water for testing may either be purchased from the Town or provided from a private source.

b. **Pressure Tests & Leakage**: The Contractor shall test completed sections of line, including fittings, with water. This testing, however, does not relieve the Contractor of his responsibility to repair or replace any cracked or defective pipe. All work necessary to secure a tight line shall be performed by the Contractor. Testing shall be performed in the presence of the Town's authorized representative and the Contractor. Final acceptance from the Town shall be contingent upon all pressure and leakage tests yielding satisfactory results.

Pressure Test: The newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for two hours to a leakage test. Raise the pressure by pump to 150 psi, 150% of design working pressure, or test pressure as shown on the drawings, whichever is greater. Measure the pressure at the low point on the system compensating for gauge elevation. Maintain this pressure (+ or – 5psi) for 2 hours. If pressure cannot be maintained using reasonable pumping rate, determine cause, repair, and repeat the test until successful. The allowable leakage shall be no greater than allowances shown in Table 6A - Hydrostatic Testing, Section 5.2, of AWWA C 600-93, *AWWA Standard for Installation of Ductile Iron Water Mains and Their Appurtenances*. A copy of this chart is located at the rear of the Town of Clayton specification 02510 – *Water Distribution*. Contractor shall be responsible for all costs, labor, materials, and equipment to perform the testing. All visible leaks, broken or cracked pipe, valves, etc. shall be repaired.

i. Prerequisite conditions for testing shall be as follows:

- All pipe has been laid and the trench backfilled.
- Valves shall be properly located, operable and at correct elevation.
- All reaction anchors have had sufficient set of 3 days. High early strength concrete, 4,500 psi or greater, may be used to reduce number of days.
- Lines shall be properly vented where entrapped air is a consideration.
- All construction activities on the project, that requires trenching or excavation within the limits of the line location, shall be completed prior to pressure testing of line.

3.10 PUMP STATIONS AND FORCE MAINS

A. **General:**

Pumps shall be submersible grinder pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater.

Submersible Pumps: Pumps shall be submersible pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater. Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by either passing solids, trash, and stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material. **Standard Detail 534.02** for typical wetwell and valve vault arrangement. See also Pre-Approved Product List for preferred pump manufactures.

Station Layout: See **Standard Detail 534.02** (sheets 3 & 5) for typical pump station site layout.

Lift station/Site, at a minimum, shall include the following:

1) Wetwell inspection and testing: See paragraph 3.9.B.9 Manhole Vacuum Testing, for manhole testing requirements.

2) Underground service by contractor from meter base and transformer (meter base and transformer provide by service provider).
3) Meter base and fusible service disconnect panel. Service to be 3 phase, 4 wire, 277/480V. Phase and voltage availability to be verified by project engineer based on site specifics.
4) Area light with switch control and photocell on 25' class 5 Press treated pole (by Contractor).
5) Under hood panel LED light (for exterior use under rain hood). Power for area light to come from control panel.
6) Provide a red flashing alarm light with horn (minimum 90dB) and alarm silence for independent high water alarm circuitry and circuitry for station loss of power). The back-up alarm system shall operate off of a 12-volt battery connection in the event of power failure. The battery system is to include a trickle charger to ensure battery integrity.
7) SCADA panel with conduit for wiring and antenna. Mounting height of antenna to be site specific. Project Engineer to verify with Town. System to be reviewed by the Engineering Director for compatibility with the Town of Clayton system.
8) Stainless Steel junction box for pump power cable and liquid level cables. Junction box to be no more than 5 feet from hatch.
9) In wet well, use floats. Transducers are not permitted without back up float system. Provide PVC conduits for pump leads (provide separate conduits for each pump).
10) Provide a #8 ground to a driven ground rod (obtain 25 ohm resistance of less. Grounding to be per NEC.
11) Provide an automatic transfer switch for generator pump (not required when backup pump is used). Dri-prime pumps required before generators.
12) Provide condensate heater on thermostat inside pump control panel.
13) Manhole for grinder pump on influent line
14) Cushioned check valves for high head applications as determine by Engineering Director. Plug vale 6 inches and larger shall be ger activated.
15) Automatic air release valves, as applicable.
16) Primary liquid level control senser (mercury float) with hand-off-automatic (H-O-A) switches and an automatic alternator. Transducers not permitted without backup float system.
17) 3-phase voltage monitor, if applicable. Indication of 3-phase power fail.
18) Glycerin or Silicone filled discharge pressure gauges, sized appropriately, visible from top of vault with ¼ turn SS ball valve, direct tap.
19) Elapsed time indicators.
20) High pump temperature protection.
21) Pump run lights.
22) Motor overload resetter
23) TLVSS Surge suppressor by Siemens
24) Dual power supply auto switchover, etc.
25) Surge relief valve and return piping to wetwell.
26) A building to house control panel may be substituted for NEMA 4 enclosure and rain hood (as shown on Standard Detail 534.04). Building to include thermostatically controlled ventilation (fan and louver) and light. Building to be approved by Engineering Director.
27) Secondary bypass connection, installed below grade, with valves and a 4-inch Godwin style quick-connect.

28) An emergency pump connection with quick connect per **Standard Detail 534.07**.
29) A precast concrete valve vault sized based on the necessary clearances.
30) 110V GFCI protected waterproof duplex receptacles.
31) Stainless steel cable attached to pump bridle. Coil up extra length at hatch. Length to be sufficient to connect to hoist.
32) Non-Freeze Flush Hydrant. See **Standard Detail 514.08**.
33) Hoist with electric winch. Capacity to be equal to 3 times pump weight, minimum 1-ton capacity hoist and wench.
34) Wet well shall be checked for flotation and shall be ballasted as reqiured to prevent buoyancy. Top slab mush have adequate thickens and be adequately reinforced designed by a NC PE.
35) Station Start-up assistance and certification: Station start-up and certification shall include an operational/witness/drawdown test.
36) Control Panel Dead Front: Panels on the primary pump station, backup pumps or generators shall comply with NFPA 70E. The following elements, when applicable for the type system under consideration, at a minimum, shall be accessible and located in front of the dead front panel and/or barriers installed to make the following accessible without being exposed to live conductors: Control/programming keyboards, all hand operated switches, H-O-A switches, disconnects, pump run lights and run time gauges, alarm silence, duplex receptacles, motor overload resetter, gauges (such as ammeter, temperature, fuel level indicator), indication of 3-phase power fail, handles, GFCI switch (on/off), circuit breakers, area light, autodialer, etc.
37) Backup Systems: The designer must provide backup service by a Dri-Prime backup pump. A backup generator can be substituted at the discretion of the Engineering Director. If a backup generator is provided, provide 1 spare pump/motor. The minimum design criteria for each option are outlined below.
38) Provide programmable auto-exercise cycle for both backup pump and generator, as applicable.

DRI-PRIME BACK-UP PUMP OPTION

Provide auxiliary diesel fired automatically activated stand-by dri-prime back-up pump with automatic reset, placed on site. All piping to be installed below grade. See **Standard Detail 534.02, sheet 5**. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. The Contractor shall provide a complete engine driven back-up pump. The back-up pump set shall consist of four-cycle, radiator-cooled, engine direct connected to pump, a unit-mounted control panel, unit-mounted fuel tank, all mounted on a common sub-base. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. Permanent skid mounted trash pump for pumping raw sewage.
b. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
c. The pump offered shall be the manufacturer's standard production model.
d. Maximum solids handling size: 3 inches

e. Maximum duty point shall meet the suction, head, and flow requirements of the station at which the pump will be located.
f. Priming System: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated, and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts consistent with the site requirements, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The Town's engineer may require a demonstration.
g. Check Valve Pump shall be supplied with an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off.
h. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. A certified continuous duty engine curve shall be supplied to the owner/engineer.
i. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode.
j. Skid Base/Fuel Tank: Integral structural steel skid type fuel tank shall be sized with sufficient capacity to provide at least 24 hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
k. Exhaust: Exhaust system shall include a stainless steel critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values.
l. Sound Attenuated Enclosure: The engine and pump shall be completely enclosed with acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to 68 dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the unit shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.
m. Automatic Starting Control System: The engine shall be equipped with a factory installed microprocessor-based controller and designed to start/stop the engine at a signal supplied by high and low level floats.
n. Engine/Pump Control Specifications: The engine shall be started, stopped, and controlled by a high performance state of the art digital controller. The controller shall be minimum NEMA 3R weatherproof enclosed, and contain an external weatherproof 12-position keypad accessible without the need

to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats. The pump controls shall provide the following minimum functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

i The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the panel.

ii In automatic mode, the unit shall conserve energy and go to “sleep.”

iii The panel shall function as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.

iv The panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.

v The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).

vi Manual-Automatic Button: In Manual Mode, Manual “Start” button starts engine and runs until “Stop” button is depressed or an emergency shutdown occurs.

vii The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.

viii The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.

ix The panel shall have only one circuit board with 8 built in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.

x Circuit breakers shall be provided with a built in control panel. Provide fuses or circuit breakers for battery charger and engine.

xi As applicable, standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form “C” relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.

xii The industrially panel shall withstand vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4°F to 176°F and an operating humidity range of 0-95% Non-Condensing.

xiii The control panel shall comply with NFPA 70E and shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; and running time meter, all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.

o. The back-up pump unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.

p. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
q. Light: The unit shall include a single switch operated 12 VDC light within the enclosure.
r. Floats: The unit shall be supplied with 1 float assembly including 2 normally open (N/O) floats which shall integrate with the engine control panel via a single multi-pin plug. Bypass pump "on" float to be placed above the high water alarm.
s. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
t. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes; all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.
u. The backup pump shall be equipped with an automatic transfer switch to start pump and transfer operation to emergency operation in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
v. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
w. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
x. The Town must be furnished with one complete set of air, oil and fuel filters.
y. Provide 5-year warranty from manufacturer of Pump and Engine.

BACKUP GENERATOR OPTION

Provide auxiliary natural gas, LP gas, or diesel fired automatically activated stand-by power generator source with automatic reset, placed on site. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. Generator shall have the capacity sufficient to sequentially start and run all pumps in the pump station. The Contractor shall provide a complete engine driven generator set. The generator set shall consist of four-cycle, radiator-cooled, engine direct connected to an alternating current generator, a unit-mounted control panel, all mounted on a common sub-base. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. The generation unit shall be capable of powering the pump motors starting current, electrical systems, instrumentation/controls and alarm systems, and other auxiliary equipment as may be necessary to provide for the safe and effective operation of the pump station. The generation unit shall have the appropriate power rating to start and continuously operate under all connected loads.

b. The generation unit shall be provided with special sequencing controls to delay lead and lag pump starts unless the generating unit has the capacity to start all pumps simultaneously while the auxiliary equipment is operating.
c. The generation unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
d. The generation unit shall be protected from damage when restoration of power supply occurs.
e. The generator shall be equipped with an automatic transfer switch to start generator and transfer load to emergency in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
f. The control panel shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; AC voltmeter; voltage adjustment; frequency meter; and running time meter. Switches and gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
g. Circuit breakers shall be provided with a built in control panel.
h. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
i. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
j. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes. Lights and gauges must be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
k. The automatic transfer switches must have a disconnect on the utility service main side.
l. The generator shall comply with the following minimum requirements:
    i Engine: Four-cycle, 4 cylinder, radiator cooled, at 1800 RPM. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature.
    ii Generator: Rating shall be continuous standby service at 0.8 power factor, at 1800 RPM.
    iii Voltage: Three-phase. KW rating to match facility needs.
    iv Engine shall be equipped with an isochronous governor as manufactured by Woodall.
    v Frequency regulation shall be less than 3-cycles from no-load to full load.
m. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
n. The generator set shall be enclosed with a factory-installed weather-protective housing (sound abating enclosure to 68db @ 23 ft.) Housing

shall provide easy access to the engine-generator and instrument panel. Muffler to be designed so exhaust is not blown or sucked across the set by cooling air.

o. Included with the generator shall be a complete fuel system consisting of a fuel tank, fuel gauge, fuel lines, fuel pumps (if applicable), valves and any and all other items incidental to a first-quality installation.
p. Diesel Option: Provide integral sub-base double-walled diesel tank. The tank is to be UL approved closed-top dike type. The tank shall also be fitted with a leak sensor device. The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.
Tank shall consist of the fuel tank separate and contained within the frame. No generator weight is to be supported by the tank. Provide a drain plug at one end of the rupture basin. Provide vibration isolators between generator set and tank assembly. Provide fuel low-level alarm remote mounted.
q. LP Option: The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.
r. Provide manufacturer's recommended anti-freeze and engine block heater, per manufacturer's recommendations, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements, adjustable if possible. Provide suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
s. Provide annunciator panels with visual and audible alarms to monitor and warn of emergency operation conditions affecting line and generator power sources.
t. Provide stainless steel super critical grade type exhaust silencer mounted inside of the generator enclosure for corrosion protection.
u. Provide amp meter, voltmeter, and frequency meters with phase switches. Meter gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
v. Provide fuses or circuit breakers for battery charger and engine.
w. Provide an automatic battery charger, static type, magnetic amplifier control with DC voltmeter, DC ammeter and potentiometer for voltage adjustment. The charger is to be completely automatic and rated for the type of battery use. The charging rate is to be determined by the state of the battery and reducing to milliamp current on fully charged battery. The charger shall be 120 V., single-phase, 60 cycle, AC input with 6-amp maximum output.
x. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
y. The Town must be furnished with one complete set of air, oil and fuel filters.
z. Provide 5-year warranty from manufacturer of Generator and Engine.
aa. Provide three bound (3-ring binder) sets of Operation and Maintenance Manual for all components relative to lift station generator.

B. **Pump Certification**: Manufacturer's representative shall be present at pump start-up. See paragraph I, *Pump Station Operational/Witness Test/Start-up* requirements, below.

C. **Wetwell Coating**: Wetwell interiors shall be coated with a two component elastomeric, polyurethane, corrosion resistant coating where the primer can be applied to damp or dry surfaces.

Coating: Sherflex S; a two-component, high-solids, quick-set aromatic polyurethane. *Sherflex™ S Elastomeric Polyurethane can be applied at thicknesses of 25-60 mils [625-1500 microns]) in a single application. Link to supplier:*
https://industrial.sherwin-williams.com/na/us/en/protective-marine/catalog/product/products-by-industry.11543396/

Contractor to follow all applicable safety measures for handling and application as recommended by the Manufacturer of the coating. Comply with applicable confined space safety requirements.

D. **Wetwell/Valve Vault Hatches**: Provide access frames and covers meeting Section 2.2.22 of this specification with padlocked hasps.

E. **Force mains**: 4-inch and larger force mains shall be Protecto 401 Ceramic Epoxy lined ductile iron, PVC (green) C900 pressure pipe or HDPE (4-inch through 8-inch). For HDPE force mains, pipe shall comply with paragraph 2.1.2 D. Other PVC force mains must be approved by the Engineering Director.

Pipe joints shall be push on or mechanical joint type. Fittings shall be mechanical joint with appropriate blocking and/or rodding. Force mains shall be constructed in accordance with the plans and in accordance with the requirements applicable to water main construction.

F. **Connection of Force Mains to Existing Manholes – Manhole Corrosion Protection**: To protect the manholes (cementitious materials and metals) from Hydrogen Sulfide (H_2S) and Sulfuric Acid (H_2SO_4) corrosion, the Engineering Director may require the Contractor to line the manhole at the force main connection as well as the next 2 to 4 manholes downstream of the force main connection.

G. **Manuals/Parts**: The Town must be furnished with 3 copies of the Operation and Maintenance and Parts Manuals for the pumps/motors and/or station, pump controls, the generator unit, and the automatic transfer switch. Also, provide a spare impeller, key, nut, washer, and mechanical seal for each pump.

H. **Safety Placards**: Provide safety placards as required for structure (e.g. confined access entry) and equipment as required by OSHA shall be posted and readily visible.

I. **Pump Station Operation/Witness Test/Start-up:**

1) **Witnessed Testing**: Witnessed testing shall be performed in the presence of the Town's authorized representative and the results of the testing maintained as part of the construction record documentation. Witnessed testing shall include start-up assistance by a qualified factory representative and certification. Prior to acceptance by the Town, an operational test of all pumps,

drive, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

After construction debris and foreign material has been removed from the wetwell, the Contractor shall supply an adequate amount of clear water volume to operate station through several pumping cycles. Observe and record operation of pumps, suction (if applicable) and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration, or other operational problems.

2) **Drawdown test**: The Contractor shall conduct a drawdown test to confirm that the pump is operating at or near the required design operating point and to determine the actual pumping rate of each pump. This test shall be conducted in the presence of the Town's authorized representative, the Contractor and a representative of the pump manufacturer. The rate shall be determined by subtracting the starting static surface elevation of the water in the wetwell from the "off" elevation and multiplying the difference by the volume per vertical foot of wetwell. That number shall then be divided by the number of minutes of pump run time to affect the drop measured. This test shall be performed for each pump and the rates recorded for each pump and included as part of the record in the certified pump test.

3) **Manufacturers Start-up Services**: The manufacturer's representative shall be present at pump start up. Co-ordinate station start-up with manufacturer's technical representative. The representative or factory service technician shall inspect the completed installation. He shall calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

3.11 PIPE DESIGN LIFE

In addition to the above noted specifications, the Contractor shall secure and the manufacturer shall furnish and warrant that sanitary sewer pipe is designed for a 50-year life.

3.12 CLEANUP AND RESTORATION OF SITE

After the backfill is completed, the contractor shall dispose of all surplus material, dirt and rubbish from the site, and shall keep the site free of mud and dust to the satisfaction of the Town. The Contractor may be required to flush or sprinkle the street to prevent dust nuisance. It is important that clean up and restoration of the site follows the work closely. The Contractor shall dispose of surplus material and clean the street at the end of each day for the portion of work completed that day unless additional cleaning is required. After all work is completed, the Contractor shall remove all tools and other equipment, leaving the site free, clean, and in good condition.

TABLE II VACUUM TEST TABLE FOR MANHOLES BASED ON ASTM C1244					
MINIMUM TEST TIMES FOR VARIOUS manhole DIAMETERS FOR PRESSURE DROP FROM 10 INCHES TO 9 INCHES HG.					
	DIAMETER (FEET)				
Depth (FT)	4	4.5	5	5.5	6
	TIME (SECONDS)				
6	15				
8	20	23	26	29	33
10	25	29	33	36	41
12	30	35	39	43	49
14	35	41	46	51	57
16	40	46	52	58	67
18	45	52	59	65	73
20	50	53	65	72	81
22	55	64	72	79	89
24	59	64	78	87	97
26	64	75	85	94	105
28	69	81	91	101	113
30	74	87	98	108	121

END OF SECTION 02530

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02630 – STORM DRAINAGE

(Last revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1 – General	FHSpecInspection	Polypropylene Pipe Spec
Part 2 – Products	Laying PP & HDPE Pipe	PP/HDPE pipe installationSteelCasingPipeSpec
Part 3 – Execution	MH Frame & Cover Spec	Precast Concrete Structures
Abandoning Existing Storm Lines	Masonry Structures	Precast Boxes - Placement
Construction of Manholes/DI's	Maintenance	Ram-Nek
Drop Inlet Specs	Misc. Iron Castings	Reinf'd Concrete Pipe Spec
HDPE Pipe Spec	Mortar Joints in Conc Pipe	

PART 1 – GENERAL

1.1 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The following materials and operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

1) The pipe and fittings shall be designed, manufactured, and installed in accordance with industry standards and shall comply with the specification requirements herein.

2) Section 02275 – Trenching, Backfilling, and Compaction of Utilities

3) Section 02530 – Sanitary Sewer

4) Division 02920 – Seeding, Sodding, and Groundcover

5) NCDENR Division of Energy, Mineral, and Land Resources, *Erosion and Sedimentation Control Planning and Design Manual*

American Society for Testing and Materials (ASTM)

1) **ASTM C33**: *Concrete Aggregates*

2) **ASTM A48**: *Standard Specification for Gray Iron Castings*

3) **ASTM A536**: *Standard Specification for Ductile Iron Castings*

4) **ASTM A615**: *Standard Specification for Deformed and Plain Carbon-*

Steel Bars for Concrete Reinforcement

5) **ASTM C32**: Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)

6) **ASTM C76**: *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*

7) **ASTM C139**: *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*

8) **ASTM C478**: *Standard Specification for Circular Precast Reinforced Concrete Manhole Sections*

9) **ASTM C507**: *Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe*

10) **ASTM C655**: *Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe*

11) **ASTM C913**: *Standard Specification for Precast Concrete Water and Wastewater Structures*

12) **ASTM C990***: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*

13) **ASTM D698:** *Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3) (Standard Proctor).*

14) **ASTM D1556**: *Standard Method of Test for Density of Soil in Place by the Sand-Cone Method*

15) **ASTM D1557**: *Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (Modified Proctor).*

16) **ASTM D2049**: *Standard Method of Test for Relative Density of Cohesionless Soils*

17) **ASTM D2167**: *Standard Method of Test for Density of Soil in Place by the Rubber-Balloon Method*

18) **ASTM D2321**: *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*

19) **ASTM D2487**: *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

20) **ASTM D2922**: *Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)*

21) **ASTM D3212**: *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*

22) **ASTM D3350**: *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

23) **ASTM D3740**: *Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*

24) **ASTM D4253**: *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.*

25) **ASTM D4254**: *Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.*

26) **ASTM D4318**: *Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.*

27) **ASTM E329**: *Standard Specification for Agencies Engaged in Construction Inspection and/or Testing*

28) **ASTM F477**: *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*

29) **ASTM F2306**: *Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications*

30) **ASTM F2764**: *Standard Specification for 6 in. to 60 in. [150 mm to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications*

31) **ASTM F2881**: *Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications*

American Association of State Highway & Transportation Officials

32) **AASHTO M86**: *Concrete Sewer, Storm Drain, and Culvert Pipe*

33) **AASHTO M170**: *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*

34) **AASHTO M198**: *Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets*.

35) **AASHTO M199**: *Precast Reinforced Concrete Manhole Sections*

36) **AASHTO M206**: *Reinforced Concrete Arch Culvert Storm Drain and Sewer Pipe*

37) **AASHTO M207**: *Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe*

38) **AASHTO M242**: *Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe*

39) **AASHTO M252**: *Standard Specification for Corrugated Polyethylene Drainage Pipe*

40) **AASHTO M259**: *Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers*

41) **AASHTO M294:** *Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter*

42) **AASHTO *M330***: *Standard Specification for Polypropylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter*

1.2 REFERENCED STANDARDS ORGANIZATIONS

A. **AASHTO** American Association of State Highway Transportation Officials.

B. **ACI** American Concrete Institute

C. **ACPA** American Concrete Pipe Association

D. **AISI** American Iron and Steel Institute

E. **ANSI** American National Standards Institute

F. **AREA** American Railway Engineers Association

G. **ASCE** American Society of Civil Engineers

H. **ASTM** American Society for Testing and Materials

I. **CRSI** Concrete Reinforcing Steel Institute

J. **FS** Federal Specifications

K. **MSDS** Material Safety Data Sheets

L. **NCDEQ** North Carolina Department of Environmental Quality

M. **NCDOT** North Carolina Department of Transportation

N. **NCMA** National Concrete Masonry Association

O. **OSHA** Occupational Safety and Health Administration

1.3 SUMMARY

This section includes all equipment, labor, material, appurtenances, and services required for complete installation of storm drainage piping, ditches, structures, and specialties for municipal drainage systems.

1.4 DEFINITIONS

For the purposes of this specification, the following definitions refer to storm water drainage systems and structures that come under the authority of the Town of Clayton, North Carolina as specified within this section and other sections of this manual.

A. **Competent Person**: Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

B. **Engineering Director:** The Town's Director of Engineering or his or her authorized representative.

C. **Plans**: The approved plans, profiles, typical roadway or trench sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

D. **Public Storm Drainage System**: Drainage systems and their appurtenances required for the conveyance of public storm water from and across publicly maintained streets, roads, highways, and other public property and located within public rights-of-way and/or easements.

E. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

F. The following are industry abbreviations for various pipe materials.

1) **HDPE**: High Density Polyethylene (NCDOT Approved) double walled pipe

2) **PP**: Polypropylene double walled pipe (NCDOT Approved), gray

3) **RCP**: Reinforced Concrete Pipe

1.5 SUBMITTALS

A. Submit product data for the following:

1) Drop inlet & curb inlet iron castings; grates & frames
2) Manhole frame and covers

3) Head/end walls
4) Flared end sections
5) Concrete pipe and piping specialties
6) Precast concrete manhole castings
7) Precast concrete catch basin and junction box castings
8) Polypropylene & HDPE fittings
9) All appurtenances proposed for use on a project that may not be listed here.
10) The Engineering Director may request that the Engineer of Record provide calculations for deep bury trench conditions, wide trench conditions, pipe placed in shallow embankments, or trenches deemed to have special loading requirements/conditions. Design to be based on American Concrete Pipe Association (ACPA) Design Data 1 *Highway Live Loads on Concrete Pipe* and 9 *Standard Installations and Bedding Factors for the Indirect Deign Method*, latest edition or other applicable ACPA Design Data Resources deemed applicable.

B. Submit shop drawings:

1) For precast concrete manholes, precast concrete catch basins and junction boxes including frames and covers, precast concrete box and arch culverts, corrugated metal arch and multiplate culverts & end/headwalls, and segmental retaining walls.

2) For any product submitted as an *"or approved equal"* or that is not specifically specified in this specification or the PreApproved Product List.

1.6 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of all applicable Codes and Standards.

B. Piping materials shall be marked clearly and legibly.

1) Reinforced Concrete Pipe shall be marked as follows:

a. Pipe Class and wall type,
b. Manufacturer
c. Date of Manufacture

2) Double walled corrugated Polypropylene (PP) and HDPE pipe, end sections, pipe tees, elbows, and accessories shall be marked as follows:
a. AASHTO or ASTM Designation
b. The date of manufacture
c. Name or trademark of the manufacturer

C. Comply with all applicable AWWA and AASHTO standards.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Pipe Condition/Pipe Examination**:

1) **New Pipe Inspection – All pipe**: Inspect materials thoroughly upon arrival. Examine materials for damage. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications.

   a. **Concrete Pipe:** Check bells and spigots closely for smoothness, roundness, and honeycombing (concrete pipe), which may be a source of infiltration. Check for cracks, chips, etc. on both ends. Reject any pipe that will not provide watertight seal or is otherwise structurally deficient.

2) **Pre-Installation Inspection**: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipes damaged or deemed not to conform to these specifications shall be rejected and removed from site.

   a. **Concrete Pipe**: All concrete pipes in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells of rigid pipe must be true.

   b. **Double Walled PP and HDPE Pipe**: All double walled corrugated PP and HDPE pipe in which the pipe and fittings cannot be made to fit properly shall be rejected. Protect pipe during handling using methods recommended by the manufacturer.

B. Observe manufacturer's directions for delivery and storage of materials and accessories.

C. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.

D. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.8 PROJECT CONDITIONS

Storm Drainage Manholes – No water mains shall pass through or come in contact with any part of a storm drainage manhole. A minimum of 3 feet of horizontal separation shall be maintained between water mains and storm drainage manholes unless otherwise approved by the Engineering Director. Interference/conflict manholes will not be permitted unless otherwise approved by the Engineering Director.

See also paragraph 1.9 *Project Conditions* of section 02275, *Trenching, Backfilling and Compaction of Utilities.*

1.9 SERVICE INTERRUPTION

Contact the Town of Clayton to coordinate interruption of water, sewer, or gas service, operation of water valves, or need/use of public potable water. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Engineering Director, temporary service may be required to be provided. Provide a minimum of 72 hours' notice of a proposed utility interruption or necessary operation of valves.

1.10 COORDINATION

A. The Town of Clayton will be the sole operator of all water main valves and hydrants on the Town's water distribution system. Adequate notifications to water customers will be given by the Contractor prior to any planned interruption of service. Service is to be continuously maintained to customers in the project area. Only in the case of an emergency may a valve be closed by a Contractor. Records shall be kept of any valves closed during an emergency and the Engineering Director shall be notified of the specific valves closed at the earliest reasonable time following such valve closure.

   Before planned shut off of any water main, residents are to be notified by the Town of Clayton's representative in writing at least 24 hours in advance of cut off. The Contractor shall provide assistance to the Town in notification distribution. The Town shall be notified at least 48 hours in advance of request for operation of valves and making either a wet tap or cut-in.

B. Coordinate tie-in to municipal manholes with the Engineering Director.

C. At the direction of the Engineering Director, for work impacting sanitary sewer mains/interruption of flow, temporary pumping/bypass of sewerage flow may be required to be provided. See 02530 - *Sanitary Sewer*, *Bypass Pumping* for bypass pumping requirements and procedure.

D. **Traffic Signal Detection Systems**: When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks' notice prior to anticipated disturbance or interruption. At the discretion of the Engineering Director, the notice may be required to be published in the newspaper.

E. **Repair of pavement markings**: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.

F. **Water Service Shut-off**:

   The Town of Clayton requires adherence to the following procedures prior to shutting off water service on any existing Town line:

   1) The Contractor must receive approval for shut-off from the Engineering Director. Generally, shut-offs must occur from 9:00 AM to 11:00 AM and 2:00 PM to 4:00 PM on weekdays.

   2) After receiving approval, Contractor shall notify affected residents in writing 48 hours in advance of beginning operation.

G. Before Digging, contact ***"NC One Call"*** at 811 and the Town of Clayton at 919-553-1530 for location of services.



PART 2 – PRODUCTS

2.1 PIPE & FITTINGS

2.1.1 CONCRETE PIPE

A. REINFORCED CONCRETE PIPE

RCP shall be a minimum of Class III, Wall B and meet the applicable requirements of AASHTO M170. Concrete pipe joints shall be tongue and groove type unless otherwise specified. RCP shall conform to the requirements of applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.

RCP Class III or IV shall also meet ASTM C76*, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*.

Gasketed joints in concrete pipe shall meet the requirements of paragraph 2.2.12, *Performed Plastic Gaskets*. Mortar joints shall meet the requirements of paragraph 3.1.1 F 1), *Mortar Joints*.

Minimum pipe diameter is 15 inches unless otherwise approved by the Engineering Director.

2.1.2 HDPE CORRUGATED POLYETHYLENE PIPE

Pipe shall be high-density polyethylene corrugated exterior/smooth interior pipe. 15-inch through 36-inch diameters shall meet all the requirements of AASHTO M294, Type S *Specification for Corrugated Polyethylene Pipe, 12- to 36-inch diameter.* 42-inch and 48-inch diameters shall have minimum pipe stiffness of 20 and 17 psi, respectively, at 5% deflection; and shall meet all other requirements of AASHTO M294. Pipe joints shall be “water-tight” in-line bells with gaskets meeting ASTM F477 *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*. Minimum pipe inside diameter for pipe subject to Town of Clayton maintenance is 15 inches.

Pipe coupling bands, end treatments, pipe tees, and elbows shall conform to AASHTO M294.

2.1.3 POLYPROPYLENE (PP) DOUBLE WALL CULVERT PIPE

1) General:

   Use polypropylene pipe from sources participating in the NCDOT’s Polypropylene Pipe QA/QC Program. Use polypropylene culvert pipe that meets AASHTO M 330 for Type S or Type D, or ASTM F2881 or ASTM F2764 Double or Triple wall; and has been evaluated by NTPEP; smooth interior. Minimum pipe diameter is 15 inches.

2) End Treatments, Pipe Tees and Elbows:

   End treatments, pipe tees and elbows shall meet AASHTO M 330, Section 7.7, or ASTM F2764, Section 6.6.

Unless plain ends are shown on the approved plans, pipe end treatments for PP pipe shall have either masonry or SRW end/headwalls or have concrete flared end sections. Pipe diameters 36" or greater are required to have either concrete flared end section or end/headwalls. PP flared end sections are not to permitted unless approved by the Engineering Director.

3) Joint Performance:

Pipe shall be joined using a bell & spigot joint meeting the requirements of ASTM F2881 or AASHTO M330. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12-inch and greater diameters shall have an exterior bell wrap installed by the manufacturer.

4) Fittings:

Fittings shall conform to ASTM F2881 or AASHTO M330. Bell and spigot connections shall utilize a welded or integral bell and valley or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.

5) Marking:

Clearly mark each section of pipe, end section, tee and elbow and other accessories according to the Department's Polypropylene Pipe QC/QA Program:

i. AASHTO or ASTM Designation
ii. The date of manufacture
iii. Name or trademark of the manufacturer

2.1.4 PLAIN CONCRETE PIPE AND CORRUGATED METAL PIPE

Not permitted.

2.2 MISCELLANEOUS APPURTENANCES

2.2.1 BEDDING

See paragraph 3.3.2.C *Bedding for Structures*, 02275, *Trenching, Backfilling, and Compaction of Utilities*.

2.2.2 BRICK

Brick shall be hard clay, grade SM, ASTM C32, *Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)* and AASHTO M91.

2.2.3 CONCRETE BLOCK

Concrete block shall conform to the requirements of ASTM C139, *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*.

2.2.4 CONCRETE FLARED END SECTIONS

Concrete flared end sections shall meet all applicable requirements of ASTM C76 and AASHTO M170 except those pertaining to design. All concrete flared end sections shall be reinforced. The concrete used in flared end sections shall be air entrained and shall attain strength of 3,500-psi when tested in accordance with AASHTO T22. 3:1 slopes are required on flared ends.

2.2.5 CONCRETE PIPE TEES AND ELBOWS

With the approval of the Engineering Director, tees and elbows may be used for 60-inch and larger pipe. Concrete pipe tees and elbows shall meet or exceed all applicable requirements of AASHTO M170 for the class of pipe tee or elbow specified on the plans.

2.2.6 GEOTEXTILE FABRIC:

Geotextile fabric shall be protected from mud, dirt, dust, sunlight, and debris during transport and storage. Material shall be inert to commonly encountered chemicals; resistant to mildew, rot, insects, and rodents; and biologically and thermally stable. Geotextile fabric for subsurface installation shall not be exposed to direct sunlight for more than 24 hours before or during installation.

A. **Filter Fabric for Rip Rap**: Filter Fabric below Rip Rap and Rip Rap Beddings shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 2 engineering fabric.

B. **Fabric for Subsurface Drains**: Non-woven needle-punched fabric for subsurface drains shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 1 engineering fabric.

2.2.7 MORTAR FOR CONCRETE BLOCK & BRICK

Mortar shall be type M, ASTM C 270, *Standard Specification for Mortar for Unit Masonry* and ASTM C 144, *Standard Specification for Aggregate for Masonry Mortar.* Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No mortar that has set beyond 45 minutes shall be used unless approved otherwise by the Engineering Director and then that time shall not exceed 90 minutes.

If hollow concrete masonry units (CMU) are approved by the Engineering Director, the grout for cellular fill of block or voids is required and shall be comprised of 3000-psi ready mix concrete with pea gravel aggregate. Do not provide air entrainment unless specified by the Engineering Director.

2.2.8 MISCELLANEOUS CONCRETE

Concrete Classes (NCDOT) to Design Compressive Strength at 28 days (f'c):

Class AA	General	4,500-psi
Class A	General	3,000-psi
Class B	Massive or Lightly Reinforced	2,500-psi

Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete.* All exposed concrete shall be air entrained. Concrete strength shall be as specified on standard details and drawings. Unless otherwise specified, all concrete shall be Class A, minimum.

2.2.9 PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement*.

2.2.10 PRECAST REINFORCED CONCRETE MANHOLES

A. Precast reinforced concrete manholes shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, latest revision and AASHTO M199. Either an "O" ring joint conforming to the requirements of AASHTO M198 and ASTM C443 *Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets* or joints conforming to AASHTO M199 and ASTM C990 *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants* may be used.

Type Concrete used in the construction of the manholes shall have a minimum 28-day compressive strength of 4,000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Manholes shall have monolithic base and eccentric cone or flattop as applicable. Structures are to have steps. Manholes shall have extended bases with appropriate reinforcing. See the Pre-Approved Product List (PAPL) for approved Manufacturers.

2.2.11 PRECAST UNDERGROUND CONCRETE UTILITY STRUCTURES

A. Structures of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C913, *Standard Specification for Precast Concrete Water and Wastewater Structures* and ASTM C858, *Standard Specification for Underground Precast Concrete Utility Structures*, latest revision with preformed butyl rubber joint sealant meeting ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed flexible Joint Sealants*, latest revision. Type Concrete used in the construction of the Utility Structures shall have a minimum 28-day compressive strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Unless shown otherwise on the drawings, structures are to have steps. Steel reinforcing shall conform to the requirements of ASTM C857, *Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures,* latest revision. Structures shall be designed for an H20-44 loading in traffic areas. See the Pre-Approved Product List (PAPL) for approved Manufacturers.

B. Concrete to be minimum 4,000-PSI. Provide all reinforcing steel which meets ASTM A615 for grade 60 and welded wire fabric conforming to ASTM A185. Welded wire fabric may be substituted for rebar as long as the same area of steel is provided.

C. Place non-penetrating lift holes or pins in accordance with OSHA standard 1926.704.

D. Provide Precast structures over 4'-0" in depth with steps unless directed otherwise by the Engineering Director.

2.2.12 PREFORMED PLASTIC GASKETS (JOINT SEALER)

Preformed plastic gaskets shall meet federal specification SS-S-210A AASHTO M-198, Type B – Butyl Rubber; Type 1, Rope Form, ¾" diameter (min.); Strip Form, ¾" minimum. Sag or flow resistance and Chemical resistance shall meet ASTM C990. Preformed butyl gaskets shall be used with structures meeting ASTM C478, ASTM C990 and AASHTO M199. See the Pre-Approved Product List (PAPL) for approved Manufacturers.

2.2.13 MANHOLE FRAMES AND COVERS

Standard Frames and Covers: Manhole frames and covers shall be meet ASTM A48 *Standard Specification for Gray Iron Castings*, Class 35B, traffic frame and cover. Standard manhole frames and covers shall be manufactured to the dimensions and configurations shown on **Standard Detail C06.01** and shall have a minimum of four 1-inch diameter holes in the flange of the frame. Minimum inside diameter of the opening shall be 23 1/2 inches. Manholes castings shall be bituminous coated. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Weights shall not vary more than 5% +/- of the weight shown on **Standard Detail C06.01**.

Cast-in-Place Frames and Covers: Manhole frames and covers shall be meet ASTM A48 *Standard Specification for Gray Iron Castings*, Class 35B, traffic frame and cover. Cast-in-place manhole frames and covers shall have a minimum inside opening diameter of 24 inches. Manhole frames and covers shall be bituminous coated. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking.

Covers are to be embossed along the perimeter with the words "Storm" and "Drains to Waterway." See **Standard Detail 633.03**.

See the Pre-Approved Product List (PAPL) for approved manhole frame and cover Manufacturers.

2.2.14 MISCELLANEOUS GRAY IRON CASTINGS

Catch basin frames and grates: Supply gray iron castings meeting the requirements of ASTM A48 *Standard Specification for Gray Iron Castings*, Class 35B. Boldly fillet castings at angles and provide arrises that are sharp and perfect. No sharp, unfilleted angles or corners are permitted. Provide castings that are true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blowholes, and other defects affecting their strength and value for the service

intended. Welding is not allowed for the purpose of making a casting structurally sound. Welding for cosmetic or other purposes is not allowed without approval of the Engineering Director.

See the Pre-Approved Product List (PAPL) for approved catch basin grate and frames and NCDOT 840.03 combination frame, cover and hood Manufacturers.

2.2.15 PRECAST CONCRETE DROP INLETS

A. Drop inlet tops and bases shall be precast and shall conform to the requirements of *paragraph 2.2.11, Precast Underground Concrete Utility Structures*, as well as all applicable sections of the latest revision of the *NCDOT Standard Specifications for Roads and Structures*. Refer to **Standard Details 633.02 633.03, 633.04, 634.01, 634.02**, and **639.01**.

B. Drop inlet bases may be either precast reinforced concrete or concrete block.

C. Inlet grates shall conform to the requirements of paragraph 2.2.14, *Miscellaneous Gray Iron Castings,* and the applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.

See the Pre-Approved Product List (PAPL) for approved Precast Concrete Catch Basins & Junction Box Manufacturers.

2.2.16 REINFORCING STEEL

Reinforcing steel shall conform to ASTM A615 *Specification for Deformed Billet-Steel Bars for Concrete Reinforcement,* Grade 60.

2.2.17 RIP RAP AND RIP RAP BEDDING

Rip Rap and Rip Rap Bedding shall conform to Section 1042 – *Rip Rap Materials* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Class A, B, 1 and 2 rip rap.

2.2.18 SUBSURFACE DRAINAGE

Subsurface drains shall conform to Section 1044 – *Subsurface Drainage Materials* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision.

2.2.19 MISCELLANEOUS STORMWATER APPURTENANCES

All miscellaneous stormwater appurtenances including but not limited to End walls and Headwalls shall conform to all applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.

PART 3 – EXECUTION

3.1 PIPE INSTALLATION - GENERAL

3.1.1 CONSTRUCTION – ALL PIPE

A. **Trench Width**: Trench width shall be per **Standard Detail 511.02** unless approved otherwise by the Engineering Director. Typically, trench width is to be pipe OD plus 24 inches. Minimum pipe inside diameter is 15 inches.

B. **Pipe Laying Direction**: Place piping beginning at low point and progress uphill. Place on grade, with unbroken continuity in invert, horizontally and vertically, and on alignment as indicated on plans. Place bell or groove ends of piping facing upstream. Install gaskets, seals, sleeve, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Place non-woven Geotextile fabric around joints as specified in paragraph 3.1.1.F 3), *Wrapping Pipe Joints*.

C. **Directional changes in gravity lines**: Use manholes for changes in direction of gravity lines. The Engineering Director may permit horizontal curves in pipe alignment for pipe greater than 48 inches in diameter where pipe has been manufactured with a beveled end for the specific project application. Shop drawings shall be submitted to the Engineering Director for review and approval prior to ordering pipe. Contractor is responsible for maintaining and documenting grade check through curve to ensure conformity with vertical grade.

D. **Stringing out Pipe**: When pipe is strung out during unloading, it shall be set on high ground and in a position to prevent silt deposits, storm water, or other matter from entering the pipe prior to its placement in the trench.

E. **OSHA Trench Protection**: Adhere to all OSHA requirements for trench slope protection, particularly Subpart P, *Excavations*, of 29 CFR 1926, latest revision. Contractor is responsible for determining the proper and applicable slope based on type soil in order to meet Subpart P, *Excavations*, latest requirements. Contractor shall employ the services of a Geotechnical engineer for direction and guidance if unstable or difficult soils are encountered. In any event, the Contractor shall hold the Town of Clayton harmless for injuries and/or damages resulting from failure to properly adhere to trench protection regulations/requirements in force at the time of a failure or mishap.

F. **Pipe Laying**: Pipe shall be bedded per paragraph 3.2.7.B and D, *Trench Preparation For Pipe*, Section 02275, *Trenching, Backfilling and Compaction of Utilities*. The pipe and fittings shall be laid in the trench so that its interior surface shall conform to the grade and alignment as shown on the plans. Pipe laying shall be done in such a way as to disturb as little as possible the pipe that has already been laid. The alignment and grade of the storm main may be field adjusted whenever, in the opinion of the Engineering Director, it is necessary, so long as the changes are consistent with the Town of Clayton policy in affect at the time of the change. Changes in either grade or alignment may only occur at manholes. Where bell and spigot pipe is used, recesses shall be excavated to receive the pipe bells.

Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter. All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry. Jointing material shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory-fabricated joints shall then be placed, fitted, and adjusted in such skillful manner as to obtain the degrees of water tightness required. Lifting holes shall be plugged according to the manufacturer's recommendations. A sheet

of geo-fabric shall be placed over the plugged lifting hole extending 18" from either side of the hole.

Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade. The greatest care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.

After the trench foundation has been properly graded to receive the pipe, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced at the Contractor's expense.

All joints shall be left exposed for inspection purposes during the working day and a suitable ladder affording easy and safe access for such inspection shall be furnished.

The Contractor, at his own expense, shall make any defects due to settlement good.

1) **Mortar Joints:** The mortar in the joints shall be composed of 1 part Portland cement and two parts clean sharp sand with 15% hydrated lime, by volume, added to the mixture. The pipe shall be clean and moist when mortar is applied. The lower portion of the bell or groove shall be filled with mortar sufficient to bring the inner surface flush and even when the next joint is fitted into place. The remainder of the joint shall then be filled with mortar and a bead or ring of mortar formed around the outside of the joint. The application of mortar to the inside of joints may be delayed until fill in completed where the pipe is in excess of 30 inches in diameter. The inside of all mortar joints shall be clean and smooth upon completion of the work. Competed mortar joints shall be cured and protected by permanently wrapping the exposed outside of the mortar joint with a layer of 30# roofing felt or a nonwoven Geotextile fabric.

2) **Flexible Plastic Joint:** Flexible joints meeting the requirements of paragraph 2.2.12, *Preformed Plastic Gaskets* may be used in lieu of mortar joints. The outside of the pipe may be required to be wrapped in fabric. See paragraph 9 Wrapping Joints, below.

3) **Wrapping Joints**: In silts and sandy soils, wrap each storm drainage pipe joint with a non-woven Geotextile fabric. Fabric is to be placed a minimum of 18 inches on each side of the joint and shall lap itself a minimum of 18 inches. Where the Engineering Director directs, for subgrade drainage purposes, that the invert of the pipe joint is to be left open, placement of a non-woven Geotextile fabric is mandatory.

G. **Temporary Suspension of Work**: When the trench is left for the night or if pipe laying is suspended, all exposed ends of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plugs shall be kept in the ends of the pipeline at all times when laying is not in actual progress.

H. **Cutting or Fitting Pipe**: Whenever a pipe requires cutting to bring a pipe to the required location, the work shall be done in a satisfactory manner with an approved

cutting tool or tools that will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe. The method of cutting pipe shall be in accordance with manufacturer's recommendations. Such cuts shall be made by the Contractor without extra compensation.

I. **Joining Pipe of Different Size or Material**: A drainage structure box is required at all pipe intersections (vertical or horizontal) and changes in pipe size or pipe material. Lateral taps and branches are not permitted without a junction box. See also paragraph 2.2.5 Concrete Pipe Tees and Elbows.

3.1.2 REINFORCED CONCRETE PIPE

A. Pipe support for pipe shall provide uniform bearing for the pipe barrel along its entire length. The pipe shall be carefully laid on the prepared foundation/bedding, groove end upgrade with the tongue fully inserted and each joint checked for alignment and grade as the work proceeds.

B. Minimum pipe bedding: Provide a minimum of 4 inches of #57 stone bedding.

1) Fill haunches to springline of pipe with either #57 stone consolidated or select granular fill compacted to a minimum of 95% of the standard Proctor maximum dry density.

2) The remainder of the soil to ground surface shall be suitable material such as material conforming to ASTM D2321, Class I, II or III (see also Division *02275, Trenching, Backfilling, and Compaction of Utilities*, paragraph 2.1.1.F for list of satisfactory soils). Compact as specified in Table 2275.3 of 02275 *Trenching, Backfilling and Compaction of Utilities.* Compaction lift thickness to conform to Table 2275.4.

C. Pipe with varying wall class shall not be mixed between manholes or boxes unless otherwise approved by the Engineering Director.

D. **Bury Limitations**: **Table 2630.1** shall govern as the maximum allowable bury for concrete storm pipe:

Table 2630.1
Bury Limitations on RCP (15 through 60 inches)

Pipe Class	Maximum Depth of Bury[a]			
	Class III wall (feet)	**Class IV wall** (feet)	**Class V wall** (feet)	**Max Trench Width** (feet)
15-inch	9.5	14.5	23	4.0
18-inch	9.5	15.0	32.5	4.0
24-inch	11.5	23.0	50	4.0
30-inch	11.0	19.5	44.5	5.0
36-inch	10.5	18.0	35	6.0
42-inch	11.0	19.0	36.5	6.5
48-inch	11.5	19.5	37.5	7.0
54-inch	12.0	20.0	38.5	7.5
60-inch	12.0	20.5	38.5	8.0

[a] Based on saturated clay weighing 120 pcf, trench width as specified, class C stone bedding, 1350 plf per ft of internal diameter for class III and 2000 plf per ft of internal diameter for class IV, 3000 plf per ft of internal diameter for class V, $D_{-0.01\ crack}$

E. Join concrete pipe using either mortar or bitumastic material to seal joint.

F. As each joint is laid, visually inspect to be certain that no jointing compound gasket, or trash is protruding from the joint or lying inside the pipe.

3.1.3 DOUBLE WALLED CORRUGATED PP AND HDPE PIPE - INSTALLATION:

A. **General**: Unless otherwise permitted by the Engineering Director, HP Polypropylene double walled pipe (gray pipe) is recommended in the right of way and HDPE pipe (black pipe) outside the public right of way. Minimum pipe inside diameter is 15 inches.

B. Pipe support shall provide uniform bearing for the pipe barrel along its entire length. The pipe shall be carefully laid on the prepared foundation/bedding and each joint checked for alignment and grade as the work proceeds. Each joint shall be wrapped in a non-woven geo-fabric overlapping the joint and itself by at least 18".

C. Installation of double walled corrugated exterior/smooth interior PP or HDPE pipe shall be in accordance with ASTM D2321, *Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe, latest revision* and as directed by the Engineering Director.

D. **Minimum pipe bedding class**: Pipe bedding to be Class B. See *02275, Trenching, Backfilling, and Compaction of Utilities*, paragraph 2.1.2 *Pipe Bedding Definitions* for a description of Class B bedding.

E. The initial backfill material shall be minimum ASTM D2321 Class I, II or III. With the exception that the initial backfill may extend of the crown of the pipe. Soil classifications per the latest revision of ASTM D2321. When required, such as with Class I or II backfill material, measures shall be taken to prevent migration of native fines into backfill material.

F. Backfill and compaction shall conform to the applicable provisions of *02275, Trenching, Backfilling, and Compaction of Utilities.* To prevent displacement of pipe, backfill shall be brought up evenly on both sides of the pipe. Backfill shall be suitable material such as free-draining sands and gravel conforming to ASTM D2321, Class I, II or III (see also Division *02275, Trenching, Backfilling, and Compaction of Utilities*, paragraph 2.1.1.F for satisfactory soils). Lift thickness and compaction requirements for backfill shall conform to the requirement of Section *02275, Trenching, Backfilling, and Compaction of Utilities*, Tables 2275.3 and 2275.4.

G. **Bury Limitations**: Minimum cover over pipe shall be 18 inches in a quality backfill envelope and where subject to traffic load for 15- through 48-inch diameters in single run applications. For double wall PP (gray pipe) pipe, see next paragraph 1) below regarding 12 inches minimum cover).

Non-traffic areas shall have a minimum of 12 inches of fill in a quality backfill envelope. Maximum fill heights depend on embedment material and compaction level. The maximum allowable cover over pipe shall be limited to 10 feet. However, at the discretion of the Engineering Director:

1) The Engineering Director may permit High Performance Polypropylene double wall pipe, meeting the NCDOT Pipe Materials Selection Guide requirements, to have a minimum cover of 12 inches below the flexible pavement course with a maximum bury of 10 feet for pipe up to 48-inch in diameter provided that the installation for the pipe is subject to the installation methods found in the NCDOT Standard Drawings, Standard Specifications, and hydraulic guidelines; accounting for site conditions such as loading and soil properties. The Engineering Director must approve all installations of HP PP double wall pipe in areas subject to traffic loads with greater than 12 feet of cover.

2) Deeper bury may be permitted provided calculations are submitted and sealed by a NC Professional Engineer for the proposed application subject to the installation methods found in the NCDOT Standard Drawings, Standard Specifications, and hydraulic guidelines; accounting for site conditions such as loading and soil properties.

H. **Pipe Deflection**: A CCTV inspection is recommended for all storm drain pipe within the Town of Clayton. When inspection by CCTV indicates a potential for excessive deflection, a deflection test (15" through 36" diameter) may be requested by the Town Engineer. A deflection test will be performed not less than 30 days following completion of backfill operations.

For 15 through 36" diameter, the pipe shall pass a manual 5% deflection mandrel go or no go test. A deflection of greater than 5% and no more than 7.5% shall be allowed only with the approval of the Engineering Director. Pipe up to 48" shall be hand measured, measuring pipe ID at both vertically and horizontally at the pipe spring line.

I. **Leakage testing** (only when ordered by Engineering Director): All polypropylene joints require watertight joints meeting the requirements of ASTM D3212. Leakage/low pressure air testing is not a common practice or requirement for storm drainage systems. However, when a leakage test is requested by the Engineering Director (when leakage conditions are suspect and warrant evaluation/testing), leakage rates of pipe shall not exceed 50 gallons/inch diameter/mile/day or per ASTM 1417 or F2487. Contact pipe manufacturer for recommended leakage rates if more restrictive.

3.2 MANHOLE CONSTRUCTION FOR STANDARD MANHOLES AND DROP INLET BASES

A. **Standard Manholes and Drop Inlet Bases**: Manholes shall be constructed in accordance with the NCDOT Standard Details and the Town of Clayton **Standard Detail 532.03** with the following exceptions:

Flexible boots and precast concrete inverts will not be required.

Joints will be as specified in the product section of this specification.

The pipe opening in precast units shall be at least 4 but not more than 8 inches larger than the outside diameter of the pipe. Pipe openings shall be formed (cast by manufacturer), drilled, or neatly cut as approved by the Engineer.

The Contractor may use brick and masonry block or concrete pipe cutoffs in conjunction with mortar to fill the void between pipe culverts and precast structures. Such materials shall be thoroughly wetted and bonded with mortar. The remaining exterior and interior void shall be filled and sealed/slicked with mortar to the contour of the precast structure.

The standard joint shall be sealed on the interior of the structure, after installation, with a non-shrink hydraulic cement mortar.

Do not plug weep holes. Place a non-woven Geotextile fabric over weep holes.

Pour concrete inverts in all structures. Concrete shall be in compliance with products section for miscellaneous concrete of these specifications. Shape manhole channel with a smooth semicircular bottom matching inside diameter of the connecting pipe/pipes. Change directions of flow with a smooth curve of as large a radius as the manhole size will permit. Change size and grade of channels gradually and evenly. Shape the shelf to provide a slope between 1 and 2 inches per foot towards the invert.

Manholes shall be installed plumb.

B. **Adjustments**: The Contractor shall exercise care in the ordering of structures so that the use of brick for leveling and adjustments can be avoided or minimized. Where adjustment of a manhole is required, grade rings shall not be used unless otherwise approved by the Engineering Director. Where adjustment of the inlet is required, the use of bricks is approved, provided that the entire void between the flat-top and inlet is also filled with brick and mortar to uniformly distribute loading of the inlet. The depth of bricks shall not exceed 12 inches before removal of the cone or flat-top is necessary for adjustment (see **standard detail C06.03**).

On all storm manholes, a mastic joint material shall be placed between the frame and cover and the cone or grade ring.

When applicable, during the installation of manholes, if frame and cover is near or within wheel path in roadway, turn cone to place the frame out of wheel path.

C. **Replacement/Rehabilitation of Existing Manholes**:

When a new manhole is necessary, the old manhole must be completely removed and a new precast manhole set in its place. Where the old manhole is of satisfactory quality, the Contractor will make connection thereto as directed by the Engineering Director at no additional cost even if it is necessary to modify the bottom of the manhole to meet the new grade. Such extras are considered incidental to the manhole connection cost.

3.3 PRECAST REINFORCED CONCRETE STORM DRAINAGE STRUCTURES (Flush Wall, Waffle and Knockout Panel Type):

A. **Design Requirements**: See paragraph 2.2.11, Precast Underground Concrete Utility Structures

1) **Formed Inverts**: All boxes shall have formed inverts. Invert forming is to be performed after the pipe penetrations have been made, the annular space around the pipe grouted and the pipe sawn flush with the interior face of the structure.
2) Seal joints with a flexible butyl rubber.

B. **Box Size**: The outside pipe diameter plus 2" or the opening required for frame and grate is the minimum structure size whichever is greater.

C. **Maximum Depth** (manhole junction boxes and catch basins): Limit maximum depth to top of bottom slab for waffle wall structure to 10'-0"; limit solid wall structure to 15'-0" unless approved otherwise by the Engineering Director.

D. **Grade Adjustment**: Precast storm drainage boxes with knockout panels shall be set to the prescribed grade designated on the construction drawings. Boxes shall be placed on a stone bed of a minimum of 6 inches of #57 stone. Boxes shall be adjusted to final grade by the addition of either precast reinforced concrete grade rings or solid clay or concrete masonry with type M mortar. Boxes may not be saw cut to lower the grade unless first approved by the Engineering Director and then by no more than 2 inches. Due to the potential for grade variation in setting the structures, and to avoid cutting the boxes, it is recommended that boxes be ordered slightly short of the depth required to permit final grade adjustment by adding risers. However, the total depth of riser ring or masonry adjustment shall not exceed 8 inches.

E. **Pipe Penetration(s) Into Boxes**:
1) Cut or form openings for pipe to provide required size and location. Remove knockout panels by saw cutting. Cut to pipe OD plus 2 inches.
2) Orient waffle wall structures so that pipes enter through the knockout/waffle panels only.
3) Pipes may enter through the corners of solid wall boxes if a minimum of 6" of wall is provided above the hole.
4) Patching: The pipe shall be placed in the hole and the annular opening grouted the full 360 degrees of the pipe diameter with concrete. The grouted pipe penetration shall be inspected prior to backfilling. Once the concrete collar has set (4 days minimum), pipe(s) protruding into the box shall be cut flush with the inside face of the box and the annular edge grouted to form a smooth entrance.

F. **Manhole Junction Boxes**: Every junction box shall have manhole access. No blind manholes are permitted.

G. Frame and grate height may be adjusted with concrete or brick in accordance with Town of Clayton specifications. Use manhole frame and cover as indicated on the plans. Reinforce manhole opening in top as shown on standard details or as designed by NC Professional Engineer for required loading condition.

H. Precast boxes may be used for the following standard details: NCDOT standard details 840.01, 840.02, 840.04, 840.05, 840.13, 840.14, 840.15, 840.17, 840.18, 840.19, 840.26, 840.27, 840.28, 840.31, 840.32, 840.34, 840.35, 840.36, 840.45, and 840.46 and for the Town of Clayton **Standard Details 633.02, 633.04**, and **634.01**.

3.4 MASONRY STRUCTURES:

A. **Design Requirements**:
   1) **Invert Forming**: All boxes shall have formed inverts. Invert forming is to be performed after the pipe penetrations have been made, the annular space around the pipe grouted and the pipe sawn flush with the interior face of the structure.

B. Masonry construction shall conform to Section 834, *Block Masonry Construction – General and* Section 840, *Minor Drainage Structures* of the NCDOT *Standard Specifications For Roads and Structures,* latest edition. Clay brick structures are not permitted.

C. **Maximum Depth/Wall Thickness**: The maximum height of an unreinforced masonry drainage structure with 8-inch walls shall be limited to 8'-0" from invert of the outlet pipe to the top of the casting. Depths greater than 8 feet shall have 12-inch walls. Basins over 8 feet, measured from invert of the outlet pipe to the top of the casting, shall be designed by a NC Professional Engineer and approved by the Engineering Director. 4-inch masonry walls are not permitted on drainage structures. Bottom slabs on drainage structures shall be reinforced when the box depth exceeds 8 feet, the box width exceeds 5 feet in width by 5 feet in length, or the box is subjected to H20 loading from truck traffic.

   Top and bottom slabs to be designed by NC Professional Engineers and approved by Engineering Director for H20 loading condition.

D. **Maximum Wall Span**: The maximum horizontal span of an 8-inch thick wall shall not exceed 8 feet for boxes 8 feet or less in depth and 10 feet for boxes 12 feet or less in depth.

E. **Manhole Junction Boxes**: Every junction box shall have manhole access. No blind manholes are permitted.

F. **Pipe Penetrations**: Inside of boxes shall allow for 6 inches of clearance on both sides of pipe. The dimension shown on the structures in the standard details are minimum box dimensions. For boxes with greater dimensions, either corbel walls, add a reinforced concrete top slab, or lengthen the box by adding additional grates and frames.

G. **Steps**: For structures over 4'-0" in depth, provide steps. Steps are to be located on a nonpipe wall. Steps to meet OSHA requirements.

H. **Grade Adjustment**: Frame and grate height may be adjusted with concrete or brick in accordance. Use manhole frame and cover as indicated on the plans. Reinforce manhole opening in top as shown on standard details or as designed by NC Professional Engineer for required loading condition.

I. Mortar in masonry structures is to be minimum type M.

J. Masonry boxes may be used with the Town of Clayton **Standard Details 633.02, 633.04,** and **634.01** and with the applicable NCDOT standard details shown with masonry.

3.5 CONSTRUCTION OF MISCELLANEOUS APPURTENANCES

Head walls, end walls, and other miscellaneous storm drainage items shall be constructed in accordance with the latest edition of the NCDOT *Standard Specifications For Roads and Structures* and the applicable NCDOT standard details.

3.6 ABANDONING STORM DRAINAGE LINES & MANHOLES

A. **Storm Lines**: Unless directed otherwise by the Engineering Director, when an existing storm drainage line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout (flowable fill) pumped into the line until line is completely filled.

B. **Manholes**: When an existing manhole, either partially or wholly, is designated to be abandoned and the storm lines, either entering or exiting the manhole, have been abandoned according to the preceding paragraph, the upper portion of the manhole shall be removed to a minimum of 18 inches below the proposed finished grade, or as determined by the Engineering Director, NCDOT #57 stone dumped into the manhole, and the stone vibrated to effect consolidation of the stone. The remainder of the fill between the top of the manhole and the finished subgrade is to be backfilled as follows. Where the manhole is located within a roadway right of way, backfill around manhole with NCDOT # 57 Stone and consolidate. Outside roadway right of ways, filter fabric shall be placed over the stone, suitable material of a compactable nature shall be placed over the top of the manhole, and the material tamped.

3.7 SLOPE ANCHORS

All lines on slopes equal to or greater than 20% slope shall have concrete anchors placed around the pipe directly below the bell end of the line. The anchors shall be spaced every other joint unless otherwise shown on the plans and constructed to the dimensions shown on the construction.

3.8 EXCAVATION OF DRAINAGE CHANNELS

A. Open storm drainage channels and ditches shall be graded and shaped in accordance with the elevations, slopes, widths, and lengths indicated on the plans except that the side slopes shall be 3:1 or flatter. The outfall elevation of the new channels and ditches shall be graded to match the flow elevations of all existing or natural channels, unless indicated or specified otherwise.

B. The drainage channels shaped with fill materials shall be compacted within the limits and in accordance with the related backfill work specified elsewhere.

C. The drainage channels shall be prepared, seeded, and mulched in accordance with the related work specified elsewhere. Where indicated on the drawings, specified, or otherwise directed by the Engineering Director, erosions control measures, such as temporary liners, rip rap, concrete liners, etc., shall be provided.

3.9 PLACEMENT OF RIP RAP AND RIP RAP BEDDING

Placement of Rip Rap and fabric shall conform to Section 876 – *Rip Rap* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision.

3.10 SUBSURFACE DRAINAGE

Installation of subsurface drainage systems shall conform to the requirements of Section 815 – *Subsurface Drainage* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision using non-woven needle-punched fabric.

3.11 INSPECTION

At any time during construction up to and including completion of entire pipe installation, the Engineering Director may inspect the work in part or as a whole in order to satisfy himself/herself that every portion of the project has been faithfully carried out in accordance with the plans, specifications, and standard details, as applicable.

If, in the opinion of the Engineering Director, a defect exists in the pipeline or its appurtenances, in some place not accessible except by uncovering, the Engineering Director may order the line to be uncovered. If it is found that after the pipe has been uncovered at the order of the Engineering Director, no defect exists or that the defects were not the fault of the Contractor, then the expense so incurred by the Contractor shall be borne by the Town.

Flush all sand, dirt, and debris from the lines prior to inspection. Provide lights and mirrors and inspect lines in the presence of the Town's representative.

Inspect the system for conformance with line and grades shown on the plans and provide record drawing measurements on record drawings.

Visual Inspection: All lines and manholes shall be visually inspected by the Town of Clayton from every manhole by use of mirrors. At the direction of the Engineering Director, areas of questionable construction may be inspected by the Town using television cameras. The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines, which do not exhibit a true and correct line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the barrel left clean for its entire length.

Laying Tolerance: Place pipe to the grades and alignment shown on the plans and within a tolerance of 1:1000 vertical and 1:500 horizontal, unless otherwise directed by the Engineering Director.

3.12 MAINTENANCE

The developer shall maintain all pipe installations in such a condition that they will function continuously from the time the pipe is installed until the development/project is accepted for maintenance by the Town. Prior to acceptance by the Town, all pipe shall be clean of sediment and free of debris. Furthermore, soil erosion and sedimentation control measures shall be installed wherever necessary, including at curb inlets for example, and maintained for the duration of the development until the project is fully stabilized. Once permanent groundcover has been established, temporary erosion control measures shall be removed and the disturbed areas landscaped and seeded.

3.13 MEASUREMENT & PAYMENT

See Section 1.4 of 00950, *Measurement and Payment.*

END OF SECTION 02630

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02740 – BASE COURSE AND PAVING

(Last revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1 – General
Part 2 – Products
Part 3 – Execution
Aggregate Base Course - Spec
Base Course, Construction
Bituminous Concrete Asphalt
Bituminous Pavement, Construction
Cement Treated Stabilization
Crack Sealing, Surface Preparation
Herbicide – Bikeway Subgrade
Geotextile (Petromat®)FHPaint
Lime Treated Soil
Milling Asphalt - Pavement Profiling
Pavement Markings
Pavement Density Req'ts (Asphalt)
Pavement Repair
Paving Operations
Seal Coat
Surface Casting Adjustments
Tack Coat

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to the furnishing, installing, and completing all base course and paving operations as shown on the approved construction drawings and standard details. Although such work may not be not be specifically indicated, the scope of work is to include setting up and preparing base course, paving, resurfacing, asphalt milling/recycling asphalt, proof rolling, adjustments to utility appurtenances (e.g., manhole frames, valve boxes, catch basin frames, etc.), cleaning, sweeping, saw cutting existing asphalt, providing pavement markings, etc., and all supplementary or miscellaneous items and appurtenances and device incidental to or related to base course and paving, and coordination with the work of all related trades; all in accordance with provisions of these specifications and the Contract Documents.

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The following operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

1) 02200 – Earthwork

2) 02275 – Trenching, Backfilling, and Compaction of Utilities

3) 02400 – Curb & gutter, Driveways and Sidewalks

4) 02920 – Seeding, Sodding, & groundcover

5) Town of Clayton **Standard Detail 401.01** *Typical Street Cross Section (Curb & Gutter Application)*

6) NCDEQ, Division of Energy, Mineral, and Land Resources, *Erosion and Sediment Control Planning and Design Manual, latest revision*

7) US Department of Labor, Occupational Safety and Health Administration (OSHA), Standard *29 CFR Part 1926, Safety and Health Regulation for Construction, Subpart P "Excavations,"* latest edition

8) 2022 NCDOT Asphalt Quality Management System, *QMS Manual* (NCDOT Materials and Tests Unit Asphalt), latest edition

9) Bicycle lanes and paths shall be designed and constructed in accordance with the latest version of the NCDOT *NC Bicycle Facilities Planning and Design Guidelines*, latest revision, NCDOT Office of Bicycle and Pedestrian Transportation

American Society for Testing and Materials (ASTM)

1) **ASTM C33:** *Standard Specification for Concrete Aggregates*

2) **ASTM C136**: *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*

3) **ASTM D422**: *Standard Test Method for Particle-Size Analysis of Soils (for classification purposes only)*

4) **ASTM D698:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (Standard Proctor)*

5) **ASTM D1556:** *Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method*

6) **ASTM D1557:** *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (Modified Proctor)*

7) **ASTM D1883**: *Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils*

8) **ASTM D2049**: *Standard Method of Test for Relative Density of Cohesionless Soils*

9) **ASTM D2167:** *Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method*

10) **ASTM D2487:** *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

11) **ASTM D2922**: *Test Methods for Density of Soil and Soil-Aggregate in*

Place by Nuclear Methods (Shallow Depth)

12) **ASTM D2937**: *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*

13) **ASTM D3740**: *Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*

14) **ASTM D4253**: *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*

15) **ASTM D4254**: *Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*

16) **ASTM D4318**: *Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.*

17) **ASTM D7382**: Standard Test Methods for Determination of Maximum Dry Unit Weight of Granular Soils Using a Vibrating Hammer

18) **ASTM E329**: *Standard Specification for Agencies Engaged in Construction Inspection and/or Testing*

19) **ASTM E303** *Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester*

20) **ASTM E548**: *Standard Guide for General Criteria Used for Evaluating Laboratory Competence*

American Association of State Highway & Transportation Officials

21) **AASHTO M145:** *Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*

22) **AASHTO T2** *Standard Method of Test for Sampling of Aggregates*

23) **AASHTO T99**: *Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.)*

24) **AASHTO T180**: *Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop*

25) **AASHTO T191**: *Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method*

26) **AASHTO T204**: *Density of Soil In-Place by the Drive Cylinder Method*

27) **AASHTO T205**: *Standard Method of Test for Density of Soil In-Place by the Rubber-Balloon Method*

28) **AASHTO T209** *Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot-Mix Asphalt (HMA)*

29) **AASHTO T308** *Standard Method of Test for Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method*

1.3 SUMMARY

A. This section includes furnishing all equipment, labor, tools, materials, and services required for complete installation of aggregate base courses and bituminous concrete pavement structures and specialties for municipal street and greenway systems. The scope of work shall include, but is not limited to:

1) Traffic control

2) Subgrade fine grading and proof rolling

3) Base course conditioning and fine grading

4) Proof rolling base course

5) Adjustments to utility appurtenances such as valve boxes, manhole frames, catch basin frames, etc.

6) Paving, asphalt milling, asphalt recycling and overlays as applicable

7) Cleaning and preparing existing pavements to be resurfaced, which may include but is not necessarily limited to, saw cutting pavement, crack sealing, full depth patching, sweeping/brooming, cleaning, flushing, geotextile (e.g., Petromat®), etc.

8) Cleanup

9) Pavement markings as applicable

1.4 DEFINITIONS

For the purposes of this specification, the following definitions refer to roadway and street systems that come under the authority of the Town of Clayton, North Carolina as specified within this section and other sections of this manual.

A. **Aggregate Base Course**: A layer of graded aggregate materials (ABC unless otherwise specified by the Engineering Director) of a specified thickness placed between the subgrade and the paving course.

B. **Asphalt Sealcoat**: A liquid coating of asphaltic/petroleum-based sealer applied as a protective coating to asphalt-based pavements to provide a layer of protection from the elements.

C. **Base Course**: A layer of bituminous material of a specified thickness placed between the subgrade or aggregate base course and the intermediate or surface bituminous paving course.

D. **Bikeway/Greenway**: A facility, and its appurtenances, used for the public conveyance of pedestrians and/or bicyclists that is maintained by the Town of Clayton, the North Carolina Department of Transportation, or other entity.

E. **Engineering Director**: The Town's Director of Engineering or his or her authorized representative.

F. **Paving Fabrics** (for overlays): Due to their properties, paving fabrics are known to improve pavement performance and extend pavement life. Along with asphalt tack coat, paving fabrics, as part of an overlay system, can eliminate water intrusion through the asphalt by creating a pavement moisture barrier between pavement layers. Paving fabrics are typically nonwoven propylene fabrics.

G. **Plans**: The approved plans, profiles, typical roadway and/or cross-sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

H. **Porous Asphalt Pavement**: Porous asphalt pavement is a type of porous pavement structure specifically designed to allow rainfall and runoff to flow into and through the pavement structure.

I. **Public Road System**: Roadway, streets, and their appurtenances required for the conveyance of the motoring public that are maintained by either the Town of Clayton or the North Carolina Department of Transportation.

J. **Intermediate Course**: A layer of bituminous material of a specified thickness that is placed between the subgrade or base course and the surface bituminous paving course.

K. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

L. **Subgrade**: Surface or elevation remaining after completing the excavation or top surface of a fill or backfill immediately below pavement structure, concrete or topsoil materials, as applicable.

M. **Subgrade Stabilization**: The modification of roadbed soils by admixing with stabilizing or chemical agents that will increase the load bearing capacity, firmness, and resistance to weathering or displacement.

N. **Suitable Subgrade**: A subgrade that consists of a material type and density that is approved by the Engineering Director for placement of a subsequent layer of material.

O. **Surface Course/Wearing Surface**: The top layer of a bituminous or concrete pavement structure which resists skidding, traffic abrasion, and the disintegrating effects of weather.

P. **Tack Coat**: A tack coat is a light application of asphalt emulsion between hot mix asphalt layers designed to create a strong adhesive bond without slippage. Heavier applications may be used under porous layers or around patches where it also functions as a seal coat. A tack coat sometimes functions as a more long-term sealer to protect the substrate from moisture.

Q. **Prime Coat**: A prime coat is the application of a bituminous binder applied to a non-bituminous granular base as a preliminary treatment before the application of bituminous surfacing. An asphalt emulsion prime coat protects the integrity of the granular base during construction.

R. The following are standard abbreviations for various industries, agencies, and documents:

1) **AASHTO** American Association of State Highway Transportation Officials.

2) **ANSI** American National Standards Institute

3) AREA American Railway Engineers Association

4) **AREMA:** The American Railway Engineering and Maintenance of Way Association

5) **ASTM** American Society for Testing and Materials

6) **FS** Federal Specifications

7) **HMA** Hot Mix Asphalt

8) **JMF** Job Mix Formula

9) **MSDS** Material Safety Data Sheets

10) **MUTCD** Manual on Uniform Traffic Control Devices

11) **NCDEQ**: North Carolina Department of Environmental Quality

12) NCDOT North Carolina Department of Transportation

13) **NPDES**: National Pollutant Discharge Elimination System

14) OSHA Occupational Safety and Health Administration

15) RAP Recycled Asphalt Pavement

16) RAS Reclaimed Asphalt Shingles

1.5 SUBMITTALS

A. Submit job-mix formula for each mixture to be supplied within 30 days after contract is awarded.

B. Roadway core sample density reports.

C. **Material Test Reports**: Provide from a qualified testing agency test results and interpretation for compliance of the following requirements indicated:

1) Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for fill or backfill.

2) Laboratory compaction curve according to ASTM D1557 for each on-site borrow soil material proposed for fill and backfill.

D. Submit product data and shop drawings for concrete manhole adjustment rings.

1.6 QUALITY ASSURANCE

A. **Geotechnical Testing Agency Qualifications**: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing as documented according to ASTM D3740 and ASTM E548.

B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

C. Comply with the Quality Assurance requirements in the 2022 NCDOT Asphalt Quality Management System, *QMS Manual* (NCDOT Materials and Tests Unit Asphalt), latest edition.

D. The contractor shall comply with applicable requirements of the North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, “Erosion and Sediment Control plans and permit as applicable.

1.7 TESTING SERVICES

A. The Testing Laboratory shall be approved by the Engineering Director and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation.

B. Specific test and inspection requirements shall be as specified herein.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Plant operations shall be in accordance with the applicable sections of Section 610, *Asphalt Concrete Plant Mix Pavements* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

B. Limitation for producing and placing ashpalt mixtures shall comply with Section 610-4, *Weather, Temperature, and Seasonal Limitations For Producing and Placing Asphalt Mixutures*, of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

C. Storage shall be in accordance with Section 610-6, *Hot Mix Storage Systems* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

D. Hauling and Spreading shall be in accordance with Section 610-7, *Hauling of Asphalt Mixture* and Section 610-8*, Spreading and Finishing* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

E. Delivery:

1) Hauling equipment shall be loaded in a manner to minimize segregation of the mix.

2) Haul trucks must park in a designated area to minimize tracking of tack coats.

3) Once loaded, haul trucks shall proceed immediately to the job site.

1.9 COORDINATION

A. Coordinate manhole and valve box adjusting with the Engineering Director.

B. Coordinate tie-in to municipal roadways with the Engineering Director.

C. After placement of aggregate base course to subgrade elevation, and prior to asphalt placement, the Contractor shall provide a means of preventing runoff from ponding on the stone base in front of catch basins/curb inlets and softening the either the aggregate base course or subgrade soils.

D. All new paved areas shall have positive drainage to eliminate ponding. Where new paved areas join existing, measures shall be taken to incorporate positive drainage to eliminate ponding.

E. Repair of pavement markings: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.

PART 2 – PRODUCTS

2.1 AGGREGATE BASE COURSE

Aggregate Base Course material shall be designated as ABC in accordance with Section 520, *Aggregate Base Course*, and Table 1005-1 *Aggregate Gradation - Coarse Aggregate* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

2.2 ASPHALT SURFACE TREATMENT

Asphalt Surface Treatment shall be in accordance with Section 660 *Asphalt Surface Treatment* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

2.3 ASPHALT TACK COAT

Asphalt Tack Coat shall be in accordance with Section 605 *Asphalt Tack Coat* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

2.4 BITUMINOUS CONCRETE PAVEMENTS

Bituminous Concrete Pavements shall be in accordance with Section 610-3 *Composition of Mixtures (Mix Design and Job Mix Formula)* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision.

2.5 CEMENT TREATED BASE COURSE

Cement Treated Base Course shall be in accordance with Section 540, *Cement Treated Base Course* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision or as specified by the Engineering Director.

2.6 GEOTEXTILE PAVEMENT OVERLAY SYSTEM

A needle punched non-woven polypropylene Geotextile fabric saturated with uncut bituminous cement equal or exceeding Petromat® 4599 Type 1 geotextile as manufactured by Propex, Inc. The fabric is to be placed between a prepared original pavement surface (see paragraph 3.9, *Geotextile pavement overlay System*) and a bituminous concrete overlay. The fabric shall meet the following physical properties:

Physical Properties			
Property	**Test Method**	**Units**	**Value**
Grab tensile strength	ASTM D4632	lbs.	90
Grab tensile elongation	ASTM D 4632	%	50
Mullen Burst	ASTM D 3786	psi	180
Mass Per Unit Area	ASTM D5261	oz/ yd^2	3.6
Asphalt retention	ASTM D 6140	gal/yd^2	0.20
Melting Point	ASTM D276	Degrees F	320
UV Resistance	ASTM D4355	%	70 at 150 hours

2.7 LIME-TREATED SOIL

Lime-Treated Soil shall be in accordance with Section 501 *Lime-Treated Soil* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision or as specified by the Engineering Director.

2.8 PRIME COAT

Prime Coat shall be in accordance with Section 600 *Prime Coat* of the NCDOT *Standard Specifications for Roads and Structures,* latest revision or as specified by the Engineering Director.

PART 3 – EXECUTION

3.1 GENERAL

Construction and testing shall conform to the applicable sections of Division 6 – *Asphalt Pavements* of the NCDOT *Standard Specifications for Roads and Structures,* latest

revision. Other requirements for base course and pavement are also set out on the drawings and on the Standard Details shown in the Town of Clayton standard street details.

3.2 PAVEMENT, PATCHES, REPAIR AND REPLACEMENT

A. **General**: This work shall consist of replacing subbase stone, and bituminous material in the street in areas where it becomes necessary to remove the original pavement such as for sewer trenches, water main trenches, storm drainage pipe ditches, etc. Pavement repair shall be the type to match the existing street pavement as shown on the drawings or as determined by the Engineering Director**.**

B. **Cutting Pavement**

Where a utility line is proposed to be placed in an existing paved area, the edges of the pavement for the utility line shall be cut in a straight line, parallel to the pipe on each side (see **Standard Detail C01.03**) for the width of the pavement cut). Perform cutting operations prior to installation of line to avoid excessive removal of pavement. Care shall also be taken during installation of pipe to avoid damage to adjoining paved surfaces.

C. **Surface Tolerances**

The bituminous patched surface will be tested using a 10-foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not exceed ¼-inch allowing for the contours of the existing pavement. All humps or depressions exceeding the specified tolerance shall be corrected or the defective work removed and replaced with new material. Any deviation from this standard will be at the discretion of the Engineering Director who may require a 50-foot overlay if the patch is not acceptable.

3.2.1 PERMANENT PAVEMENT REPAIR

Excavation: Excavation of the existing pavement and subbase shall be made to the depth shown on the construction drawings or as directed by the Engineering Director. Before the placement of any stone, concrete, or bituminous material, a representative of the Engineering Director shall inspect the underlying subgrade. The Contractor shall be responsible for correcting any ruts or soft yielding places to the depth necessary to pass a proof roll of the subgrade before placing of the bituminous material.

A. **Bituminous Pavement Repair**

Aggregate Base Stone: The aggregate base shall be placed in accordance with **Standard Detail C01.03** and compacted to 95% of the Standard Proctor maximum dry density based on ASTM D698. A proof roll must be passed prior to the placement of any subsequent course. For subgrade compaction requirements, see *Table 2200.2A* of *02200 Earthwork*.

Bituminous Concrete Pavement: Placing of the bituminous concrete pavement shall be performed in accordance with **Standard Detail C01.03**. Compact mix to 92% based on AASHTO T209.

1) **Bituminous Base Course**: Before placing any bituminous material, all sides of the existing pavement and subbase shall be thoroughly tacked at the rate of 0.3 Gal/SY.

2) **Bituminous Surface Course**: The finished surface shall abut the existing pavement with no overlap allowed. Care shall be taken to ensure a uniform grade between the existing pavement and the new surface.

B. **Sealing Existing Pavement Cracks and Joints**: Sealing of existing pavement cracks and joints shall conform to paragraph 3.9.C *Preparation of Asphalt and Concrete Pavement Surfaces*.

C. **Concrete Pavement Repair**

Aggregate Base Stone: The aggregate base shall be placed to a depth as shown on the drawings or as directed by the Engineering Director and compacted to 95% of the Standard Proctor maximum dry density based on ASTM D698. A proof roll must be passed prior to the placement of any subsequent course.

Concrete Pavement: Placing of the concrete pavement shall be performed in accordance with drawings or as directed by the Engineering Director. Concrete shall meet Section 1000, *Portland Cement Concrete Production and Delivery* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision except that the minimum compressive strength shall be 4000 psi air-entrained concrete. The Engineering Director reserves the right to require that the Contractor pull concrete test cylinders for verifying concrete strength.

3.3 AGGREGATE BASE COURSE (ABC)

A. **Weather Limitations**

Stabilized aggregate base courses shall not be constructed unless the atmospheric temperature is at a minimum of 35º F and rising. Any areas of completed base course that are damaged by freezing shall be reconditioned, reshaped, and recompacted.

The Town reserves the right to reject any subgrade (in-situ soil or embankment fill to receive aggregate base) that has not been approved, a subgrade that has been rained on, or a subgrade that is frozen.

B. **Subgrade Approval**

The subgrade upon which the aggregate base course is to be placed shall be prepared in accordance with the requirements 02200, *Earthwork*. Prior to any spreading operations, the subgrade shall be checked and accepted by the Engineering Director or his/her representative for adequate compaction and surface tolerances. The surface of the subgrade shall be dry and clean of all foreign substances. Any ruts or soft yielding places that may appear in the subgrade and any areas having inadequate compaction shall be corrected by loosening, removing and adding approved material, reshaping, recompacting the affected areas to line and grade, and pass a proof roll before the base course is applied. Proof-rolls shall only be conducted in minimum one block lengths as measured from center of intersection to center of intersection, from center of intersection to end of cul-de-sac, or in lengths of no less than 750 linear feet.

A proof roll of the in-situ or embankment fill subgrade must be passed prior to the placement of aggregate base course. See 02200, *Earthwork*, section 3.3.2, *Evaluation of In-situ or Embankment Fill Subgrade*, paragraph F.1) for proof roll requirements.

C. **Installation of Aggregate Base Course**

The aggregate base course shall be mixed in an approved central mixing plant of the pugmill type and water added during mixing operations in the amount necessary to provide the optimum moisture content for compacting. After mixing, the material shall be transported to the job site and placed on the roadbed by means of an approved aggregate spreader.

The aggregate base course shall be constructed in layers not less than 3 inches or more than 6 inches of compacted thickness. When vibrating with other approved types of special compacting equipment, the compacted depth of a single layer of the aggregate base course may be increased to 8 inches upon approval. The aggregate, as spread, shall be uniform in gradation with no segregation or pockets of fine or course material. Frequent template checks shall be made to ensure that a minimum amount of patching is necessary after complete compaction is secured.

D. **Compaction Operations and Density Requirements**

After mixing and spreading, the aggregate base course shall be well rolled and machined until thoroughly compacted at optimum moisture within 2% percent of optimum. Rolling shall progress gradually from the sides to the center and shall continue until the entire area of the course has been rolled by the rear wheels. Rolling shall continue until the full depth of the material has been compacted to not less than 98 percent density of the maximum dry density when tested in accordance with ASTM D1556, Standard Method of Test for Density of Soil in Place by the Sand-Cone Method, latest revisions.

A proof roll of the aggregate case course must be passed prior to the placement of either asphalt or concrete pavement. See 02200, *Earthwork*, section 3.3.2, *Preparation of Areas to Receive Asphalt Pavement or Concrete*, paragraph H.2) for proof roll requirements.

Aggregate base course density shall also conform to the applicable requirements of NCDOT *Standard Specifications for Roads and Structures*, Section 1006, *Aggregate Quality Control/Quality Assurance*, latest revision.

E. **Grading Tolerances of Final Surface**

After final rolling, the surface shall be inspected and any irregularities in excess of ½ inch shall be corrected. Aggregated base course shall conform to the lines, grades, and typical cross sections shown on the plans, details or as established by the Engineering Director within a tolerance of +/- ½ inch. Any irregularities in the surface shall be corrected by scarifying, remixing, reshaping, and recompacting until a smooth surface is obtained.

F. **Maintenance**

If directed by the Engineering Director, the aggregate base shall be open to public traffic for at least 2 weeks before being surfaced. During this time, the surface shall be protected against loss of fine material by the addition of moisture as necessary. However, traffic shall be kept off the base between preparatory final compaction and surfacing.

Prior to paving, if traffic has been allowed on the base, the contaminated surficial aggregate base course material surface shall be bladed off, the material removed from the street, new base course aggregate material brought in to replace the quantity removed, the base course compacted, and the surface fine graded to the cross section shown on the plans (and/or Town of Clayton standard details) and the tolerances noted in paragraph E, above.

3.4 CEMENT TREATED STABILIZATION

Cement Treated Stabilization shall be performed in accordance with NCDOT *Standard Specifications for Roads and Structures*, Section 540, latest revision or as specified by the Engineering Director.

3.5 LIME-TREATED SOIL

Lime-Treated Soil shall be performed in accordance with NCDOT *Standard Specifications for Roads and Structures*, Section 501, latest revision or as specified by the Engineering Director.

3.6 BITUMINOUS CONCRETE PAVEMENT

3.6.1 CONDITIONING EXISTING SURFACES

A. **Protection of Manholes and Valve boxes prior to final paving:**

Where the rim and cover of a manhole or a valve box extends more than 1 inch above an unfinished road surface, a temporary layer of asphaltic concrete feathering shall be installed to provide a smooth transition from 1 inch below the edge of the rim and cover to the unfinished road surface. A 12:1 slope ratio shall be used. The exposed sides of the manhole and/or valve box shall be painted bright orange or as specified by the Engineering Director. Prior to final paving, Contractor shall remove feathering completely and apply asphalt tack coat to binder to ensure proper asphalt adhesion. See **Standard Detail C05.01**.

B. **Tacking Existing Surface:**

1) **General**: A tack coat of liquid asphalt shall be applied between the existing bituminous surface and each bituminous course placed thereafter. The tack coat shall conform to the applicable requirements of NCDOT *Standard Specifications for Roads and Bridges*, Section 605 *Asphalt tack Coat*.

Bitumen classed as cutbacks or emulsions shall be applied ahead of the paving operations, and the time interval between applying and placing the paving mixture shall be sufficient to ensure a tacky residue providing maximum adhesion of the paving mixture to the base. The mixture shall not be placed on tack coats that have been damaged by traffic or contaminated by foreign material. Traffic shall be excluded from such section.

On rich sections or those that have been repaired by the extensive use of bituminous patching mixtures, the tack coat shall be eliminated when directed by the Engineering Director.

Exception: When bituminous concrete asphalt to be placed has a total thickness of 4 inches or more, priming with liquid asphalt material will not be required on base material.

2) **Tacking**: Contact surfaces of curbing, gutters, manholes, and other structures projecting into or abutting the pavement and cold joints of bituminous concrete asphalt shall be painted with a thick uniform coating of liquid asphalt prior to placement of bituminous concrete asphalt mixture. Application of tack at joints, adjacent to curbs, gutters, or other appurtenances shall be applied with a hand wand at the rate of 0.2 gallons per square yard. At joints, the hand wand applied tack shall be 2 feet in width with 4 to 6 inches protruding beyond the joint for the first pass. Tack for the adjacent pass shall completely cover the vertical face of the mat edge, so that slight puddling of asphalt occurs at the joint and extends a minimum of 1 foot into the lane to be paved. Milled faces that are to remain in place shall be tacked as above for the adjacent pass. Use of tack at longitudinal joint vertical faces will not be required when paving in echelon.

Tack shall be applied in such a manner as to offer the least inconvenience to traffic and to permit a minimum of one-way traffic without pickup or tracking. Care shall be taken to prevent spattering of adjacent pavement, structures, trees, and private property. Any spattering will be cleaned up by the Contractor at no cost to the Town.

Payment for tack shall be included in bituminous concrete asphalt prices.

3) **Tack Coating Horizontal Surfaces**: See paragraph 3.7, *Tack Coat*.

C. **Removing Depressions/Irregularities**

Where irregularities in the existing surface would result in a course more than 3 inches in thickness after compaction, the surface shall be brought to a uniform grade by placing a thin layer of bituminous concrete asphalt not exceeding the minimum thickness as recommended for that type of mix. Then the material shall be thoroughly compacted until it conforms to the surrounding surface. The mixture used shall be the same as that specified for the surface mix to be placed.

D. **Bicycle/Greenway subgrade – Herbicide Treatment:**

Herbicides shall conform to Section 1060-13, *Herbicides* of the NCDOT Specifications for Roads and Structures, latest revision ***shall be applied to the aggregate base course and/or subgrade no more than 15 minutes prior to paving***. The rate of application shall be as recommended by the herbicide manufacturer. Herbicides shall not be used where they may contaminate water used for irrigation and drinking purposes.

3.6.2 PAVEMENT PROFILING - MILLING

The work included under this contract item shall consist of the removal of existing bituminous surfaces of in-place pavements on various streets within the Town of

Clayton, to produce the desired profile, cross-section, and surface conditions as specified by the Engineering Director. All removed material shall become the property of the Contractor.

The Contractor shall plan and prosecute a schedule of operations so that milled roadways will be overlaid with bituminous concrete asphalt as soon as possible, and, in no instance, shall the time lapse exceed 7 days after the milling operations, unless otherwise specified. The milled areas of the roadway shall be kept free of irregularities and obstructions that may create a hazard or annoyance to traffic in accordance with the requirements of NCDOT *Standard Specifications for Roads and Structures*, Section 607, *Milling Asphalt Pavement*, latest revision.

The Contractor shall plan and prosecute the milling operation to avoid trapping of water on the roadway. At the discretion of the Engineering Director, cutting drainage slots in roadway shoulders or inlets may be required, at no additional cost. The Contractor shall also restore the cut drainage slots afterwards at no additional cost to the Town.

A. The equipment and manpower furnished for this work shall be:

1) A cold milling machine capable of cutting at least 2 inches deep and 55 inches wide in flexible pavement while leaving a uniform cut and rideable surface capable of handling traffic prior to placement of a new bituminous overlay. The ground speed of the machine shall be independent of the cutting equipment. The machine shall maintain a sharp cutting edge at all times. The machine shall have a self-contained water system for control of dust and fine particles. The machine shall be capable of working in wet and dry conditions with temperatures down to 32º F.

2) The width of the machine shall be such to allow for one lane of traffic at all times. The machine shall be capable of cutting within 1 inch of manholes, valve box tops, and the face of turndown face walks with a minimum radius of 5 feet.

3) If the machine is not self-loading, then a capable loader shall be furnished for placing the material onto trucks.

4) A power broom is to be used for cleaning the planed surfaces.

5) The Contractor shall furnish all hose and water.

6) Traffic control and flagman are to be provided by the Contractor.

7) All work associated with the milling operation shall be performed by the Contractor (such as asphalt removal at intersections and around utilities and clean up in yards).

B. The construction methods shall be as follows:

Where bituminous pavement extends into the existing curb and gutter, the Contractor shall be required to plane at different slopes. The first cuts shall remove the material existing above the gutter line. These cuts will be made at the appropriate gutter slope (1/2”:1’) for both 24- and 30-inch standard curb and gutter

sections. Any curb and gutter with a different slope will be planed at the existing curb and gutter slope.

The last cuts shall remove the material to a depth of 1” below the gutter line with a street cross-section slope of 1/4”:1’ or to slope of existing street.

Where curb and gutter exists but the pavement is at or below the existing gutter line, the pavement will be cut to a depth of the thickness of overlay below the gutter line while adjusting street cross-section to 1/4”:1’ toward the centerline of the street.

Where existing straight curbing has pavement built up to expose less than 6 inches of curbing, the pavement will be planed down on grade of 1/4":1’ or whatever the existing grade of the street back to the street centerline until a desired height of curbing is exposed.

Where center of pavement has correct crown but, pavement has rutting or ripples (possibly caused by vehicular braking), the pavement will be planed to the depth necessary to remove all such defects.

If milling encroaches into base, the area(s) shall be patched the same day.

C. Surface Casting Adjustments/Preparation: See paragraph *3.10.B, Surface Casting Adjustments*.

3.6.3 PAVING OPERATIONS

A. **Bituminous Concrete Pavement Operations**

Bituminous concrete pavement operations shall be in accordance with Section 610 of the NCDOT *Standard Specifications for Roads and Structures*, latest revision. This work includes producing, weighing, transporting, placing and compacting the plant mix; furnishing aggregate, asphalt binder, anti-strip additive and all other materials for the plant mix; furnishing and applying tack coat as specified; furnishing scales; maintaining the course until final acceptance of the project; making any repairs or corrections to the course that may become necessary; providing and conducting QC as specified in Section 609; and surface testing of the completed pavement.

B. **Transportation of Bituminous Mixture**

Transportation of bituminous mixture from the paving plant to the site shall be in trucks having tight, clean, and smooth beds. Each load shall be covered with canvas or other suitable material of ample size to protect it from the weather and to prevent the loss of heat. Prior to discharge from the hauling vehicle, the temperature of the mixture shall be within a tolerance of plus 25ºF to minus 25ºF of the specified job mix formula temperature. Any loads wet excessively by rain will be rejected. Hauling over freshly laid material will not be permitted.

C. **Placing and Furnishing**

Bituminous concrete asphalt shall only be placed when the weather conditions are suitable (see paragraph I, *Placement Limitations*, below).

Bituminous concrete asphalt shall not be placed until surface upon which it is to be placed has been approved by the Engineering Director. Prior to delivery of surface course material, the base course shall be completed for receiving the surface course material and shall be kept from traffic, with the exception of the mixture vehicles and those other vehicles necessary for the placement of asphalt.

For strip paved streets, the edge of the pavement shall be marked by means of a continuous line placed and maintained a sufficient distance ahead of the paving operation to provide proper control of the pavement width and horizontal alignment.

Contact surfaces of curb and gutters, manholes, etc., shall be painted with a thin uniform coating of cut-back asphalt just before the surface mixture is placed against them. Immediately adjacent to headers, flush curbing, gutters, liners, and other structures, the surface course mixture shall be spread uniformly high so that after the final compaction it will be approximately 1/8 inch above the edge of the structure.

An approved asphalt paver shall be used to distribute the bituminous mix over the widest pavement width practicable. Wherever practicable and when the capacity of sustained production and delivery is such that more than one paver can be operated, pavers shall be used in echelon to place the wearing course in adjacent lanes. Crossovers, as well as areas containing manholes or other obstacles that prohibit the practical use of mechanical spreading and finishing equipment, may be constructed using hand tools. However, care shall be taken to obtain the required thickness, jointing, compaction, and surface smoothness.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6 inches. However, the joint in the wearing surface shall be at the centerline of the pavement if the roadway comprises two traffic lanes or at lane lines if the roadway is more than two lanes in width. Offsetting layers will not be required when adjoining lanes are paved in echelon and the rolling of both lanes occurs within 15 minutes after laydown.

The Contractor shall have a certified Asphalt Concrete Paving Technician present during paving operations. Immediately after placement and screeding, the surface and edges of each layer shall be inspected and straightedged by the technician and necessary corrections performed prior to compaction. The finished pavement shall be uniform and smooth.

The placement of bituminous concrete shall be as continuous as possible and shall be scheduled such that the interruption occurring at the completion of each day's work will not detrimentally affect the partially completed work. Material that cannot be spread and finished in daylight shall not be dispatched from the plant unless the use of artificial lighting has been approved. When paving is performed at night, sufficient light shall be provided to properly perform and thoroughly inspect every phase of the operation. Such phases include cleaning planed surfaces, tack application, paving, compacting, and testing. Lighting shall be provided and positioned such as to not create a blinding hazard to the traveling public.

Adjacent Residents/Business Contacts: The Contractor shall distribute to each residence or business along a road to be paved, a flyer approved by the Engineering Director on Town letterhead, with notification of the work to be done and the dates it will be performed. Also, to be included is a request that all vehicles

be removed from the street during this time period. The flyers are to be delivered 3 to 7 days prior to the actual start date of the construction.

Parking Interference: During paving operations, the Contractor shall be responsible for furnishing and erecting temporary "no parking" signs on each street that is to be paved to prevent residents from parking their vehicles in the way of construction. The signs shall be erected at least 24 hours prior to paving operations and on each side of the street as necessary.

D. **Layer Thickness**

Minimum Layer Thickness: Bituminous concrete SUPERPAVE pavement courses shall be placed in layers not exceeding 4.0 times the nominal maximum size aggregate in the bituminous mixture. The maximum thickness may be reduced if the mixture cannot be adequately placed in a single lift and compacted to required uniform density and smoothness. The minimum thickness for a pavement course shall be no less than 2.5 times the nominal maximum size aggregate in the bituminous mixture. These nominal maximum and minimum lift depths correlate as shown in the table below. If the proposed total depth for a prescribed mix type exceeds the maximum single layer depth shown in the table, the asphalt must be placed in **two lifts;** the first lift having a thickness of not less than the minimum single lift depth shown in the table. Asphalt cores must be taken to confirm thickness and compaction.

Table 6.3.6.D

Mix Type	Minimum Single Lift Depth[a] (inches)	Maximum Single Lift (inches)	Maximum Layer Depth (inches)
SA-1	0.5	1	2
S4.75A	0.75	1	2
S9.5B	1.0[b]	1.5	3
S9.5C, D	1.5	2	3
I19.0C	2.5	4	4
B25.0C	3[c]	5.5	---

[a]Approximate Minimum Thicknesses; lower rates bay be used for leveling courses
[b]For S9.5B placed on top of an Asphalt Surface Treatment (AST) MAT coat, minimum lift thickness is 1.5 inches.
[c]For B 25.0X placed on unstabilized subgrade, minimum lift thickness is 4.0 inches.
Source: NCDOT 2022 HMA/QMS Manual, Section/Table 3.3.

E. **Joints**

1) **General**: All joints shall present the same texture, density, and smoothness as other section of the course. The joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to ensure a continuous bond between old and new sections of the course. All contact surfaces of previously constructed pavements shall be painted with a thin, uniform coat of hot bituminous material just before the fresh mixture is placed.

Care shall be exercised when tying into curb and gutter and newly over-layed travel lanes to ensure a uniform grade and joint.

The Contractor shall construct the final riding surface to tie into the existing surface by cutting a notch 1 inch deep by 1 inch wide for all tie-ins to existing pavement, including driveways and ramps. Suitable guidelines or devices shall be used to ensure cutting of the joint on a true line. The joint shall be thoroughly cleaned and dried prior to being sealed. This work shall be done at no additional cost to the Town.

Method of temporary joints at the end of each workday shall be approved by the Town of Clayton Engineering Director.

In addition to the following, both transverse and longitudinal joints shall conform to Section 610-11, paragraphs (A) and (B), respectively of the *NCDOT Standard Specifications for Roads and Structures*, latest revision.

2) **Transverse**: The roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is to be discontinued or when delivery of the mixture is interrupted to the extent that the unrolled material may become cold. Construct a sloped wedge ahead of the end of the full depth pavement to provide for compaction and the protection of the full depth pavement. Place a paper parting strip beneath this wedge to facilitate joint construction unless waved by the Engineering Director. Before paving operations are resumed, remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth to expose an even vertical surface for the full thickness of the course.

3) **Longitudinal**: In all cases, the edges of cold longitudinal joints shall be cut back to expose an even, vertical surface for the full thickness of the course prior to constructing the adjacent pavement.

F. **Compaction**

Immediately after the bituminous mixture is placed and struck off and surface irregularities are corrected, the mixture shall be thoroughly and uniformly compacted by rolling.

During compaction of bituminous concrete asphalt, the roller shall not pass over the end of freshly placed material except when a construction joint is to be formed. Edges shall be finished true and uniform.

The surface shall be rolled when the mixture is in the proper condition. Rolling shall not cause undue displacement, cracking, or shoving.

The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density. However, the minimum and maximum roller weight shall be 5 tons and 10 tons, respectively.

Immediately after the hot mixture is placed, it shall be sealed with rollers. Thereafter, rolling shall be a continuous process, insofar as practicable, and all parts of the pavement shall receive uniform compaction. In the event that the rolling operation is not able to properly keep up with the placement of the mixture, the finishing machine shall be stopped, and no mixture shall be laid until the rolling has been caught up.

Rolling shall begin at the sides and proceed longitudinally parallel to the center of the pavement, each trip overlapping at least ½ the roller width, gradually progressing to the crown of the pavement. When abutting a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves, rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.

Displacements occurring as a result of reversing the direction of a roller, or from other causes, shall be corrected at once by the use of rakes or lutes and addition of fresh mixture when required. Care shall be taken in rolling not to displace the line and grade of the edges of the bituminous mixture. The motion of the roller shall be at all times slow enough to avoid displacement of the hot mixture. All roller marks must be eliminated.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with a very small quantity of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Edges of bituminous pavement surfaces shall be true curves or tangents. Irregularities shall be corrected.

The surface of the compacted course shall be protected until the material has cooled sufficiently to support normal traffic without marring.

G. **Asphalt Pavement Density Requirements**

Superpave mix design criteria for mixes listed in Table 610-2 of the NCDOT *Standard Specifications for Roads and Structures* shall be minimum (based on AASHTO T209) 85.0% for S4.75A (when S4.75A mix is applied at a rate of 100 lbs/sy or higher) , 90.0% for SF 9.5A mix and 92% for all other mixes (minimum % of Maximum Specific Gravity [Gmm], Table 610-7 of the 2022 NCDOT Asphalt QMS Manual). Density shall also meet Table 610-3 of the NCDOT *Standard Specifications for Roads and Structures*.

H. **Pavement Samples**

Bituminous pavement coring sampling and density test reports shall be submitted at completion of project in accordance with the requirements of the NCDOT *Standard Specifications for Roads and Structures* Section 609, *Quality Management System For Ashphalt Pavements*, latest revision.

Perform density sampling and testing on all pavements as outlined in Sections 10.4 and 10.6 of the NCDOT *Asphalt QMS Manual*, unless otherwise approved by the Engineering Director. Provide reports on the results of the coring in accordance with Section 609-5, *Contractor's Quality Control System* of the NCDOT Standard Specifications for Roads and Structures, latest revision.

Suitability of the samples shall be based on the limits of precision specified in Section 609-7, *Quality Assurance* of the NCDOT Standard Specifications for Roads and Structures, latest revision.

I. **Placement Limitations - Temperature**

No surface course (SF9.5A, S9.5A) shall be laid unless the ambient air and surface temperature is a minimum of 40ºF and rising. See Table 3.6.3-I below for the temperature requirements for other mixes.

Assure temperature of the mixture immediately before discharge from the hauling vehicle is within a tolerance of ±25°F of the specified JMF mix temperature. Asphalt mixtures, when ready to dump into the mechanical spreader, that have temperatures of less than 225º F will be rejected. All compaction rolling shall be completed prior to the mat cooling down to 175º F. Finish rolling may be performed at a lower mat temperature.

Do not place asphalt material when the air temperature, measured in the shade away from the artificial heat at the location of the paving operation and the road surface temperature in the shade is less than the temperatures shown in the following table:

Table 3.6.3-I
Asphalt Placement – Minimum Temperature Requirements[1]

Asphalt Concrete Mix Type	Minimum Surface and Air Temperature
B25.0B, C	35°F
I19.0B, C, D	35°F
Type SF9.5A, S9.5B,	40°F[2]
S9.5C	45°F[2]
S9.5D	50°F

[1]Table 610-6 of NCDOT Standard Specifications for Roads and Structures

[2] For the final layer of surface mixes containing RAS, the minimum surface and air temperature shall be 50°F.

Other placement limitations, to include but not limited to, mixture temperatures, and cold weather paving shall be in accordance with Section 610, *Asphalt Concrete Plant Mix* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

J. **Pavement Tolerance**

The surface will be tested by using a 10-foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not be more than 1/4 inch. Humps and depressions exceeding the specified tolerance shall be corrected, or the defective work shall be removed and replaced with new material.

3.7 TACK COAT

Procedures and equipment shall be in accordance with Section 605, *Tack Coat* of the NCDOT Standard Specifications for Roads and Structures, latest revision and Section 3.6 Bituminous Concrete Pavement of these specifications.

All tack coat materials shall meet the NCDOT *Standard Specifications for Roads and Structures* Standard Specification requirements and will be either Asphalt Binder Grade PG 58-28 or PG 64-22 or Asphalt Emulsion, Grade RS-1H, CRS-1H, CRS-1, HFMS-1 or CRS-2 unless otherwise approved by the Asphalt Mix Design Engineer or the Engineering Director.

Tack coat application rates in gallons per square yard (gal/sy) and application temperatures for tack coat, see Tables 605.1 and 605-2, respectively of the NCDOT *Standard Specifications for Roads and Structures*, latest revision.

Apply tack coat only when the surface to be treated is dry and when the atmospheric temperature measured at the location of the paving operation away from artificial heat is 35°F or above. Do not apply tack coat when the weather is foggy or rainy.

All castings, the gutter edge, and other surfaces which pavement rests against shall be painted with asphalt tack coat material by way of a hand brush, or other approved means, prior to the placing of the surface course. All asphaltic cement or other materials which discolor the surface of concrete structures and items which are spilled or placed on such surfaces shall be removed at the Contractor's expense. The inability to remove such foreign and disfiguring stains shall result in the complete removal of the structures so stained or disfigured, and these removed structures or surfaces shall be replaced at his expense. Particular care shall be taken to prevent tack coat from getting into and on gutter areas.

3.8 ASPHALT SURFACE TREATMENT (AST)

Section 660, *Asphalt Surface Treatment* of the NCDOT *Standard Specifications for Roads and Structures*, latest revision. The type of AST (i.e., Asphalt Seal Coat, Sand Seal, Mat and Seal, etc.) and application rates shall be as shown on the approved drawings or specified in the contract documents.

3.9 GEOTEXTILE PAVEMENT OVERLAY SYSTEM

A. Asphalt Distributor

The distributor truck shall be metered and capable of spraying tack coat at a specified uniform application rate. The applicator shall provide uniform coverage without gaps, partial overlaps, skipping, dripping or otherwise create heavy streaking. The truck shall be equipped with a hand spray nozzle to distribute tack coat in locations inaccessible by the truck.

No will be permitted. The distributor shall also be equipped with a hand spray having a single nozzle and positive shut-off valve.

B. Fabric Laydown Equipment

Mechanical or manual lay down equipment shall be capable of laying the geotextile smoothly. The fabric can be installed with a mechanical unit mounted on the front of a tractor or on the back of the distributor truck. Manual units can

be used for small jobs. Provide stiff bristle brooms, squeegees, or pneumatic rollers to smooth fabric. Provide all tools such as scissors or blades for cutting fabric and brushes for applying asphalt sealant to Geotextile overlaps.

Do not permit traffic directly on fabric.

C. **Preparation of Asphalt and Concrete Pavement Surfaces** (Sealing Existing Pavement Cracks and Joints):

1) **General**: The surface on which the geotextile or an overlay is to be placed shall be reasonably free of dirt, oil, water, vegetation, or other debris. If the surface is rough but stable, the Engineering Director may require milling or placement of a leveling course before installation of an overlay or a Geotextile pavement overlay system.

2) **Crack Treatment**: Cracks less than 1/8" wide do not require any special attention before application of the tack coat. Cracks from 1/8" to 3/8" should be filled with a liquid crack sealant so that the tack coat cannot seep down into the crack. Fill cracks larger than 3/8" with a more stable crack filler, such as hot or cold asphalt mix, emulsion slurry, or commercially available crack filler (see paragraph 3), below). Highly cracked, but sound pavements may be more economically prepared with a leveling course. If the crack filler contains an emulsified asphalt or cutback asphalt, allow it to cure completely before placing the tack coat and fabric. Otherwise, the paving fabric will form a membrane that can trap volatiles or moisture, leading to separation of the paving fabric from the pavement surface. Fill cracks flush with or slightly below the existing pavement surface. If cracks are overfilled, such that the filler mounds up above the surface of the pavement, a noticeable bump in the pavement can reflect up through to the surface of the surface course. Fillers shall be allowed to cure prior to either geotextile or overlay placement.

3) Give careful attention to areas that show signs of structural or subgrade distress or failure, such as alligator cracking or pavement deformation. Repair potholes with a properly compacted hot mix or other similar filler as directed by the Engineering Director. In these areas, the or the Project Engineer (or the Engineering Director in the absence of a Project Engineer) will specify procedures for removing or stabilizing the questionable pavement areas before overlay.

4) Conform to the requirements of NCDOT *Roadway Specifications for Road and Structures*, Section 657 *Sealing Existing Pavement Cracks and Joints*, latest revision.

D. **Surface Preparation**

Washed concrete sand may be spread over an asphalt-saturated geotextile to facilitate movement of equipment during construction or to prevent tearing or delamination of the geotextile. Hot-mix broadcast in front of construction vehicle tires may also serve this purpose. If sand is applied, excess quantities shall be removed from the geotextile prior to placing the surface course.

Sand is not usually required. However, ambient temperatures are occasionally sufficiently high to cause bleed-through of the asphalt sealant resulting in undesirable geotextile adhesion to construction vehicle tires.

Neither the asphalt sealant nor the geotextile shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. Air and pavement temperatures shall be sufficient to allow the asphalt sealant to hold the geotextile in place. For asphalt cements, air temperature shall be 50°F and rising. For asphalt emulsions, air temperature shall be 60°F and rising.

E. **Application of Tack**

The surface should be dry prior to tack coat and fabric placement. The specified rate of asphalt sealant application must be sufficient to satisfy the asphalt retention properties of the geotextile and bond the geotextile and overlay to the old pavement.

When emulsions are used, the application rate must be increased to offset water content of the emulsion.

Application of the sealant shall be by distributor spray bar, with hand spraying kept to a minimum. Temperature of the asphalt sealant shall be sufficiently high to permit uniform spray pattern. For asphalt cements the minimum temperature shall be 300°F. To avoid damage to the geotextile, however, the distributor tank temperatures shall not exceed 320°F.

A spray pattern for asphalt emulsion is improved by heating. Temperatures in the 130°F to 160°F range are desirable. A temperature of 160°F shall not be exceeded since higher temperatures may break emulsion.

The target width of asphalt sealant application shall be the geotextile width plus 6 in. The asphalt sealant shall not be applied any farther in advance of geotextile placement than the distance the Contractor can maintain free of traffic.

Asphalt spills shall be cleaned from the road surface to avoid flushing and geotextile movement.

When asphalt emulsions are used, the emulsion shall be cured prior to placing the geotextile and final wearing surface. This means essentially no moisture remaining.

Fully saturate the fabric and provide a bond to the overlay without providing excess tack coat that could mix with the overlay of the asphalt. The optimum amount depends on the porosity of the old pavement, fabric weight, tack coat material, and other variables. Verify the applications rates with the Geotextile manufacturer and coordinate with the Engineering Director prior to application.

Required cure time varies with emulsion type, humidity, ambient temperature, and other factors. Verify the cure times with the Geotextile manufacturer and coordinate with the Engineering Director prior to application.

F. **Fabric Placement**

The geotextile shall be placed onto the asphalt sealant (calendared or smooth side up) with minimum wrinkling prior to the time the asphalt has cooled and lost tackiness. Drive the vehicle straight to avoid wrinkling. Turns should be made

gradually. For sharp curves or corners, cut fabric to size and place by hand. As directed by the Engineering Director, wrinkles or folds in excess of 1-inch shall be slit and laid flat.

Blooming and/or pneumatic rolling will be required to maximize geotextile contact with the pavement surface.

Overlap of geotextile joints shall be sufficient to ensure full closure of the joint but should not exceed 6 inches. Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. A second application of asphalt sealant to the geotextile overlaps will be required if in the judgement of the Engineering Director additional asphalt sealant is needed to ensure proper bonding of the double geotextile layer.

Removal and replacement of geotextile that is damaged will be the responsibility of the Contractor.

The tack coat or mix temperature should not exceed 320ºF when the fabric is placed.

G. **Hot mix overlay and protection**

The temperature of the mix shall not exceed 320°F. In the event asphalt bleeds through the geotextile causing construction problems before the overlay is placed, the affected areas shall be blotted by spreading sand. To avoid movement of, or damage to the seal-coat saturated geotextile, turning of the paver and other vehicles shall be gradual and kept to a minimum.

All areas in which paving fabric has been placed should be paved during the same day. If the fabric becomes wet, allow to dry before paving. Unless directed otherwise by the Engineering Director, a minimum compacted asphalt thickness of 1.5 inches shall be placed to provide adequate heat and pressure to bond the systems.

Trafficking the geotextile will be permitted for emergency and construction vehicles only.

Prior to placing a seal coat (or thin overlay such as an open-graded friction course), lightly sand the geotextile at a spread rate of 0.15 to 0.20 pounds per square foot, and pneumatically roll the geotextile tightly into the sealant.

3.10 PREPARATION OF PAVEMENT FOR RESURFACING

A. **Preparation of Surface**: Prior to beginning paving operations, the existing areas to be resurfaced shall be thoroughly cleaned by the Contractor to the satisfaction of the Engineering Director. This cleaning shall include sweeping of the streets with a power operated broom, cutting excess debris with a grader, washing with a water truck, and hand cleaning any debris left over after this operation is complete. Cleaning operations shall commence just prior to the resurfacing of streets. In addition, the Contractor shall expose any existing paved areas, which have been covered by soil, grass, or debris. These areas shall be thoroughly cleaned, herbicide applied, and tacked before resurfacing. Any excess material

left over after this operation shall be removed or spread out to the satisfaction of the Engineering Director. No additional payment shall be made for this work.

When the surface of the existing pavement or base is irregular, it shall be brought to a uniform grade and cross section as directed by the Engineering Director. The surface on which the bituminous concrete is to be applied shall be prepared in accordance with the requirements of the applicable specifications.

When specified, prior to placement of bituminous concrete, longitudinal, and transverse joints, and cracks in cement concrete pavement shall be sealed by the application of an approved joint sealing compound.

Sealing Existing Pavement Cracks and Joints: See paragraph 3.9.C, *Preparation of Asphalt and Concrete Pavement Surfaces,* above.

B. **Surface Casting Adjustments/Preparation**

Any surface casting, such as water boxes, manholes, grates, cleanouts, etc., shall be set to grade prior to beginning of paving operation. All telephone manholes and gas boxes are to be adjusted by the respective utility companies or Contractor if approved by the Engineering Director. All such castings shall be adjusted within a tolerance of 1/8 inch below or flush with the asphalt finished elevation. Where applicable, concrete riser rings or brick shall be placed under manholes frames (see **Standard Detail C06.03**) to raise the rim to the proposed finished pavement grade. The Contractor shall be required to coat the top of any such casting with a suitable coating material to prevent adhesion of the bituminous material to the casting. A tack coat of bituminous material, conforming to the requirements of these specifications, will be applied prior to resurfacing operations.

3.11 PROTECTION OF ASPHALTIC SURFACE COURSE

Sections of newly placed and compacted asphalt surface course shall be barricaded and protected from all defects for a period of at least 8 hours until they have become properly hardened by cooling. Protect asphalt from petroleum products during and following placement of surface course.

If patching is required to make repairs, the base material in place shall be removed to a minimum depth of 4 inches, replaced with bituminous concrete base course (type B-25.0B) and surfaced with 2 inches of S9.5B bituminous asphalt concrete.

3.12 PAVEMENT MARKINGS

A. **General**

1) **Applicable Design Standards**: Marking layout, dimensions, colors, etc. shall be subject to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD) and the applicable details of the NCDOT *Standard Roadway Drawings*, latest revision. Unless otherwise noted below, pavement marking materials and preparation shall be of a thermoplastic material, and shall comply with Section 1087, *Pavement Markings* and Section 1205, *Pavement Marking General Requirements* of the NCDOT Standard Specifications for Roads and Structures, latest revision.

Prior to marking, all pavements are to be free of grease, oil, mud, dust, dirt, grass, loose gravel, and other deleterious material.

B. **Thermoplastic Striping**:

1) All thermoplastic striping shall be a NCDOT approved mix that minimizes the slipperiness of the marking surface.

2) Thermoplastic traffic line paint shall be a reflectorized thermoplastic pavement striping material applied to the road surface in a molten state by mechanical means. It shall have surface application of glass beads which, upon cooling to normal pavement temperature, will produce an adherent reflectorized stripe of the specified thickness and width.

3) The markings must be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics, such that it is capable of fusing with itself and previously applied thermoplastic when heated with a torch.

4) The markings must be able to be applied in temperatures down to 32°F, without any special storage, preheating, or treatment of the material before application.

5) Thermoplastic paint shall comply with NCDOT *Standard Specifications for Roads and Structures*, Section 1087-2C, *Thermoplastic Composition*, latest revision. The material shall contain at least 30 percent by weight of graded premixed glass beads. It must contain a minimum of 10% titanium dioxide pigment (ASTM D476 Type 2). All pavement markings, without drop-on beads and/or media, shall visually match the color chips that correspond to the Federal Standard 595b for the following colors:

   Crystal: Color No. 17886 (White)
   Yellow: Color No. 13538
   Black: Color No., 37038

6) The surface must have a minimum skid resistance value of 55 BPN when tested according to ASTM E303, *Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester,* latest revision.

7) The material, when applied at a temperature range of 400° F to 440° F and shall set to bear traffic in not more than 2 minutes when the air temperature is 50 °F. Minimum thickness shall be 90 mils for arrows, edge lines, diagonals, and gore lines; 120 mils for centerlines, skip lines, mini-skip lines, characters, and crosswalk lines.

8) The material must be resistant to deterioration due to exposure to sunlight, water, oil, gasoline, salt or adverse weather conditions.

9) When applied to Portland concrete surfaces, the application notes above still apply, except that a compatible surface primer/sealer shall be applied prior to the application of the Thermoplastic material to assure proper adhesion.

10) Do not apply thermoplastic pavement markings between December 15 and the following March 16.

11) Provide drainage openings at intervals of 250 feet in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are a maximum of 12 inches and a minimum of 6 inches in length.

C. Existing Pavement Markings:

1) Prior to the installation of paint or thermoplastic pavement marking lines and symbols, the surface of existing pavement markings shall be cleaned by a method which does not materially damage the existing pavement surfaces.

2) Materials deposited on the pavement and adjacent surfaces as a result of the removal of pavement markings shall be removed as the work progresses.

3) When a blast removal method is used, care must be taken to protect adjacent surfaces and structures from flying debris.

4) Painting over or black out painting of existing pavement markings with black paint or bituminous solutions shall not be allowed.

END OF SECTION 02740

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02920 – SEEDING, SODDING AND GROUNDCOVER

(Last Revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

Part 1 – General
Part 2 – Products
Part 3 – Execution
E&SC Permit Req'ts
Fertilizer, Product Spec
Hyrdoseeding
Lime, Product Spec
Maintenance
Plantings
Seeding
TrenchW
Sodding
Tackifiers - Asphalt
Tackifiers – Organic
Topsoil, Product Spec

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary and incidental to placement groundcover and completing all associated work such as seedbed preparation, seeding, fertilizing, liming, mulching, placement of netting, matting, and tack, sodding and/or hydroseeding as applicable, placement of hardscape elements and fences if applicable, erosion control measures as applicable to the groundcover phase of work; all as shown on the approved construction drawings, standard details contract documents, all supplementary or miscellaneous items, appurtenances, and devices incidental to or related to placement of groundcover, cleanup, and coordination with other trades; all in accordance with provisions of these specifications, the approved construction drawings, standard details, and the contract documents.

B. When called for on the plans or contact documents, the scope of work may also include, planting bare root or balled and burlapped (B&B) plants and shrubs which may include, excavation of plant holes, planting, backfilling, watering, mulching for plantings, staking or guying, establishment and replacement planting which are not in a living or healthy condition.

C. **Locally Approved Erosion and Sedimentation Control Plan/Permit**:

1) **Erosion and Sedimentation Control (E&SC) Plan/Permit Required**: Contractor shall not commence site disturbance, clearing and grubbing or grading until the Town has issued an E&SC permit.

For land disturbing projects equaling 1 acre or more, a NPDES permit is issued.

2) **Construction Sequence and Schedule**: As part of the approved E&SC permit, the Project Engineer will include a construction sequence. Additionally, either as part of the approved E&SC plan or at the Preconstruction Conference, the Contractor shall provide to the Town a work schedule that coordinates the timing of the land-disturbing activities and the installation of erosion control measures.

3) **Post installed/inspection of E&SC Measures; Certificate of Compliance**: Following approval by the Town of Clayton of the E&SC plan (and the E&SC measures are installed and found to be acceptable with the approved E&SC plan), a certificate of compliance is issued by the Town so that the Contractor can continue land disturbing activities.

4) **Maintaining an approved E&SC plan on site**: A copy of the approved E&SC plan shall be always kept on site.

5) **NCGS § 160D-922, Erosion and Sedimentation Control**: Pursuant to NCGS § 160D-922, once a local government administering an erosion and sedimentation control program approves an E&SC plan for land-disturbing activity at a site, the local government shall allow the plan holder to begin land-disturbing activity in accordance with G.S. 160D-1110.1(h) and the approved plan, notwithstanding that other development approvals that may be required from the local government for the project have not yet been obtained. In accordance with G.S. 160D-108(e), where multiple local development permits are required to complete a development project, approval of an erosion and sedimentation control plan is not an initial development permit for purposes of the vesting protections of that subsection.

   This section becomes/became effective July 1, 2024, and applies to permit applications submitted on or after that date. Notwithstanding, refer to General Assembly of NC, Session Law 2023-142, Senate Bill 677, "§ 113A-61 *Local approval of Erosion and Sedimentation Control plans* for other related/applicable previsions.

1.2 RELATED DOCUMENTS & REFERENCE STANDARDS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. The North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, *Erosion and Sediment Control Planning and Design Manual.*

C. The following operations shall comply with the latest revision of the Codes and Standards listed below. The use of ASTM/AASHTO standard specification references without a year designation implies the most current applicable specification.

D. 02200 – Earthwork

E. 02275 – Trenching, Backfilling, & Compaction of UTILITIES

F. 02400 – Curb & gutter, Driveways and Sidewalks

G. 02510 – Water distribution

H. 02530 – Sanitary Sewer

I. 02630 – Storm Drainage

American National Standards Institute

ANSI Z60.1 American Standard for Nursery Stock

American Society for Testing and Materials

ASTM C602 Specification for Agricultural Liming Materials

ASTM D977 Standard Specification for Emulsified Asphalt

ASTM D5268 Standard Specification for Topsoil Used for Landscaping and Construction Purposes

1.3 SUMMARY

A. This section includes preparation of surfaces and application for seeding and sodding of areas proposed to be stabilized and landscaped in utility easements, on sites, in landscape buffers, along roadways and other applicable areas disturbed by construction.

B. This specification covers seeding, sodding and groundcover but excludes trees, shrubs, plants, edgings, planters, and irrigation.

C. The scope of work shall include, but is not limited to:

6) Traffic control

7) Rough and fine grading, seedbed preparation

8) Placement of lime, fertilizer, seed, mulch and/or matting, & tack

9) Hydroseeding and sodding as applicable

10) Plantings if applicable

11) Hardscape elements such as sidewalks, flumes, retaining walls, etc. are subject to the applicable specifications and requirements noted under Section 1.2, above.

12) Coordination with other trades and compliance with the applicable provisions of the approved erosion control permit/plans

13) Cleanup

1.4 DEFINITIONS

GENERAL: For the purposes of this specification, the following definitions refer to landscaping items that come under the authority of the Town of Clayton as specified within this section and other sections of this manual.

A. **Engineering Director**: The Town's Director of Engineering or his or her authorized representative.

B. **Finish Grade**: In terms of landscaping, the surface that has been established, graded, raked, and prepared to receive groundcover, fertilizer, seed, and mulch; the finished surface of planting soil.

C. **Groundcover**: The material placed on a prepared surface and used to stabilize the soil from erosion.

D. **Hydroseeding**: Hydroseeding (aka hydromulching) is a process where mulch is mixed with seed, fertilizer, tackifier (glue) and soil amendments to create a slurry that is sprayed onto bare soil. This process enables seeds to rapidly germinate and grow while the mulch keeps the soil and seed in place (limiting erosion and increasing seedling survival). Hydroseeding can occur year-round.

E. **Matting**: An open three-dimensional synthetic or organic mat consisting or randomly placed filaments and biodegradable netting. Matting is often used to protect and stabilize new or repaired embankments and slope surfaces from erosion when naturally grown vegetation cannot prevent soil erosion on its own.

F. **Mulching**: A protective covering, usually of organic matter such as straw, placed over bare earth to minimize evaporation of moisture and erosion of bare earth soils.

G. **Mulch Binders** (Tackifiers): Organic/nonpetroleum based, liquid asphaltic based, or fibrous mixture intended to bind straw and hold in place.

H. **Mulch Netting**: Lightweight plastic, cotton, or paper nets intended to be stapled over straw mulch.

I. **Plans**: The approved plans, profiles, typical roadway and/or cross-sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions, and details of the work to be done and that are a part of the contract.

J. **Pure Live Seed**: Pure live seed is the living seed of the intended grass that will germinate from a seed bag and accounts for the weight of the bag made up of impurities, weed seed, inert matter, and other crop seed.

K. **Sod**: An existing established matt of grass that has been removed from one area by a mechanical harvester and transferred to a prepared subgrade at another location; used to render a finished appearance and/or provide immediate resistance to erosion.

L. **Specifications**: The general term comprising all the directions, provisions and requirements contained or referred to in the Manual of Specifications, Standards, and Design (MSSD), including the Supplemental Specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

M. **Subgrade**: Surface or elevation remaining after completing the excavation before placement of topsoil.

N. **Tackifier**: Tackifiers are used as “glue” to bind and immobilize straw, cellulose products, or other mulch that has been applied to a seeded area. Tackifiers protect seedbeds by holding the product to the soil surface and preventing movement.

O. **Topsoil**: A native, imported, or modified soil which is primarily organic in nature, free of rocks, clumps of clayey soils and otherwise friable in texture.

P. The following are standard abbreviations for various industries, agencies, and documents:

STANDARD ABBREVIATIONS

1) **AASHTO** American Association of State Highway Transportation Officials.

2) **ANLA** American Nursery & Landscaping Association

3) **ANSI** American National Standards Institute

4) **ASTM** American Society for Testing and Materials

5) **FS** Federal Specifications

6) **MSDS** Material Safety Data Sheets

7) **NCDEQ**: North Carolina Department of Environmental Quality

8) **NCDOT** North Carolina Department of Transportation

9) **NCGS** North Carolina General Statutes

10) **NCSPA** North Carolina Sod Producers Association

11) **OSHA** Occupational Safety and Health Administration

12) **S/W** Sidewalk

13) **SRW** Segmental Retaining Wall

14) **USDA** United States Department of Agriculture

1.5 SUBMITTALS

A. Submit product data and shop drawings for the following:

1) **Seed certification**: All seed shall be labeled to show it meets North Carolina Seed Law requirements. All seed must have been tested within 6 months of planting.

2) A seed bag tag shall be submitted with final payment request from each type or mixture of seed used.

3) Topsoil analysis, if requested by Engineering Director. Soil testing shall state percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil. Report is to state suitability of topsoil for lawn growth and recommend quantities of nitrogen, phosphorus, potash nutrients and soil amendments to be added to produce satisfactory topsoil.

4) **Hydroseeding Mix**: The contractor shall submit the proposed mix of fertilizer, hydro-mulch, organic/nonpetroleum based tackifier, water, and seed to the Engineering Director for approval prior to ordering materials.

1.6 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of all applicable Codes and Standards.

B. The contractor shall comply with applicable requirements of the North Carolina Department of Environmental Quality (NCDEQ), Division of Energy, Mineral, and Land Resources, Erosion and Sediment Control plans and permit, as applicable.

1.7 TESTING SERVICES

A. Specific test and inspection requirements shall be as specified herein.

1.8 DELIVERY, STORAGE AND HANDLING

A. **Handling/Storage**:

1) See Part 3 - EXECUTION of these specifications for handling of sod materials during placement.

2) Observe Nursery's directions for delivery and storage of seed and sod materials.

3) Store and protect fertilizer and lime until items are applied.

1.9 PROJECT CONDITIONS

A. The Contractor is responsible for obtaining all applicable permits (encroachment, grading, etc.), making application, and paying permit fees.

B. Seed mixture shall be chosen to ensure the development of plants during the season of planting, and to ensure future growth and permanence.

C. Protect structures, utilities, sidewalks, pavements, and other facilities, along with lawns and existing exterior plants from damage caused by planting operations.

D. **Temporary Seeding**: Denuded areas to be graded during the construction phases that are not to be brought to final grade within 14 calendar days shall receive temporary seeding and mulching.

E. **Permenant Seeding**: Areas to be stabilized with permanent vegetation must be seeded or planted within 14 working days or 90 calendar days after final grade is reached, unless temporary stabilization is applied.

   Temporary seeding shall be used to stabilize finished grade areas if the time of year is outside the specified permanent seeding periods.

F. **Environmental - Wetlands**: Before crossing or entering into any jurisdictional wetlands, Contractor shall verify whether or not a wetlands permit has been obtained for the encroachment and whether special restrictions have been imposed. Care shall be taken not to disrupt drainage, alter, or destroy non-permitted wetlands unless a permit has been obtained. Restore areas noted on the project drawings, the contract documents, and/or in the permit. All encroachments shall be subject to US COE and NCDEQ Division of Water Quality approval and permitting conditions.

G. **Safety**: The Contractor shall keep the surface in a safe a satisfactory condition during the progress of the work.

H. After seeding and mulching, care shall be taken to prevent future runoff destruction of seeded areas.

1.10 LOCATING SERVICES

Contact ***NC811.ORG*** at 811 before digging.

1.11 COORDINATION

A. Coordinate placement of groundcover with other Contractors and with the Town of Clayton Engineering Director.

B. Proceed with planting only when existing and forecasted weather conditions permit.

C. Protect undisturbed lawns, shrubs and trees and promptly repair damages caused by seeding, sodding, and groundcover operation.

1.12 Warranty

Warranty period for groundcover: 12 months from date of substantial completion if not designated as temporary cover.

PART 2 – PRODUCTS

2.1 MISCELLANEOUS

2.1.1 TOPSOIL

A. **Topsoil**: Comply with ASTM D 5268, *Standard Specification for Topsoil Used for Landscaping Purposes,* pH range of 5.5 to 7, a minimum of 4% organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1) **On-site Topsoil Source**: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth. Provide erosion control measures to prevent erosion, and off-site deposition of topsoil.

   a. Contractor may supplement on-site source with imported or manufactured topsoil when quantities are insufficient. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches in depth. Do not obtain from swamps or marshes.

2) **Off-site Topsoil Source**: Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches in depth. Do not obtain from swamps or marshes.

2.1.2 FERTILIZER

A. **Commercial Fertilizer**: Commercial-grade complete fertilizer of neutral character, consisting of fast and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the composition as shown on **Standard Detail 350.01**.

B. **Slow-Release Fertilizer**: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the composition as shown on **Standard Detail 350.01**.

2.1.3 LIME

A. **Lime**: ASTM C602, *Standard Specification for Agricultural Liming Materials*, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent, Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

   If ordered by the Engineering Director, a pelted form of limestone with a water-soluble binder may be required to speed breakdown of limestone.

2.1.4 MULCH

A. **Straw mulch material**: Straw mulch shall consist of wheat, barley, oat or rye straw, or tame hay. The mulch material shall be air-dry, reasonably light in color, and shall not be musty, moldy, caked, or otherwise of low quality. If straw mulching results in competing stands of grain, maintenance shall include mowing of the grain weed stand to a height of 4 inches prior to reaching a height of 10 inches. Grain weed stands shall not be considered part of the minimum 95% area cover. Unacceptable grass stands shall be overseeded, after aeration by spiker, at half the original rate, as many times as necessary to establish an acceptable stand. The use of mulch that contains noxious weeds is not permitted. Straw that can be windblown should be anchored to hold in place. The contractor shall provide a method satisfactory to the Engineering Director for determining weight of mulch furnished.

B. **Other mulch materials**: Mulching materials, such as wood cellulose fiber mulch, mulch tackifiers, synthetic fiber mulch, netting, mesh and three-dimensional matting, are other mulching materials that may be required or specified on the plans for specialized locations and conditions. These materials, when specified, must be accompanied by the manufacturer's recommendations for methods of application. Wood chips are not permitted.

C. **Mulch tackifiers**: Asphalt emulsion tackifiers shall conform to the requirements of ASTM D977, Specification for Emulsified Asphalt. Emulsified asphalt may be rapid setting, medium setting, or slow setting. When directed by the Engineering Director, because of environmental considerations, nonasphaltic tackifiers may be required.

Mulch, tackifiers and nettings shall be biodegradable or photo-degradable within 2 years but without substantial degradation for 5 months. Such material shall be free of contaminants that pollute the air or waters of the US or State when properly applied. Mulch, tackifiers and nettings shall also be capable of being applied evenly such that they provide 100% initial soil coverage and still adhere to the soil surface, do not slip on slopes when it rains or is watered, do not blow off site, and dissipate rain-drop splash.

PART 3 – EXECUTION

3.1 CONSTRUCTION OF SUBGRADE

A. **EXCAVATION, GRADING AND SUBGRADE PREPARATION FOR SEEDING/SODDING**: Excavation, grading and subgrade preparation for seeding and/or sodding shall be in strict compliance with 02200, *Earthwork* and 02275, *Trenching, Backfilling, and Compaction of Utilities*, and this specification section, as applicable. The subgrade upon which this work is to be placed shall be smoothly shaped and compacted to a firm, even surface conforming to the elevation and cross-sections shown on the plans, the standard drawings, or as directed by the Engineering Director. All soft, frozen, and unsuitable material shall be removed and replaced with approved material.

B. **FINE GRADING (Trimming)**: Fine grading shall be the responsibility of the Contractor to ensure that the finished grade conforms to the proposed finished grades as shown on the plans and the applicable standard details.

3.2 SEEDING, SODDING, AND GROUNDCOVER

3.2.1 GENERAL

Seeding and groundcover includes seedbed preparation, liming, fertilizing, seeding, and mulching of all disturbed areas. Areas inside or outside the limits of construction that are disturbed by the Contractor’s operation and activity shall be seeded and mulched.

A. Unless called for otherwise on the Erosion and Sedimentation Control Plan, in areas where natural sod or vegetation has been disturbed, the area shall be fertilized, limed, seeded, and mulched in accordance with **Standard Detail 350.01**.

If a utility line is installed through a landscaped lawn, the seeding shall be modified to restore ground cover comparable to the existing lawn.

B. Seeding shall be carried out as soon as practical after the construction in any one area, and shall be maintained against erosion through the completion of the project. Seeding shall be accomplished as work progresses.

The Contractor shall be responsible for proper care of the seeded area during the period that vegetation is being established. In the event of an erosive rain before an adequate stand of vegetation has been established, damaged areas shall be repaired, fertilized, seeded, and mulched at the Contractor's expense.

C. Seeding on rights of way of NCDOT maintained roads shall be in accordance with NCDOT specifications and the requirements of the approved encroachment permit.

D. **Stockpile Area**: The Contractor is responsible for securing a material lay down and stockpile storage area. As such, the Contractor is responsible for the necessary erosion control measures, including but not necessarily limited to, a construction entrance, silt fence, temporary seeding, protection of streams/buffers, clean up and restoration of site to the satisfaction of the Town and the NCDEQ, Division of Energy, Mineral, and Land Resources, Land Quality Section. Stockpile and/or waste areas must be maintained within the limits of the areas protected by the proposed measures and otherwise temporarily seeded if to be left stockpiled over 14 days.

3.2.2 SODDING/SEEDING

A. **GENERAL**

The goal of sodding/seeding, where specified, is to return the disturbed area to its original vegetative condition, and to return the area to an aesthetically pleasing environment. Thus, all sodding/seeding shall meet the following requirements:

In most instances the areas requiring sod restoration versus seed restoration should be readily determinable by the Contractor based on preconstruction conditions. In general, where streets have roadside ditches, the area from the edge of pavement to the centerline of the ditch will be reseeded or sodded, depending on the existing condition of the grass. Installation in areas where there are no roadside ditches and traffic does not generally frequent, and has an existing good thick uniform stand of grass, shall be resodded.

Any questionable areas shall be restored in the manner (sodded or seeded) determined on site by the Engineering Director.

Vegetative restoration (sodding or seeding) shall be done as the work progresses. Areas to be protected by a vegetative cover include, but are not limited to, any areas disturbed during construction that are not otherwise stabilized by gravel, concrete, or asphaltic paving, or other impervious built-upon surface.

Any area disturbed without owner authorization will be restored by the Contractor at his own expense. In all cases the Contractor will guarantee a stand of grass over the entire area.

The work to be done to acquire the necessary vegetative cover shall include but is not specifically restricted to appropriate tilling of the area, the application of fertilizer and lime for areas to be seeded, placement of sod, or sowing of seed and placing of a straw mulch to hold the seed and soil in place until germination and growth occur.

After bringing the area to be sodded or seeded to proper grade, the entire area shall be tilled to a minimum depth of 4 inches by discing, harrowing, or other approved means. Following tilling, all large debris, all stones larger than three (3) inches on any side, sticks, roots, and other extraneous materials that surface during bed preparation shall be removed to the satisfaction of the Engineering Director and the surface leveled.

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3.2.3 MAINTENANCE OF SEEDED/SODDED AREAS:

Contractor shall provide a suitable backflow prevention devise for filling water tank trucks or trailers. Contractor shall water sodded/seeded areas as necessary for providing for growth of sod/seed.

The Contractor shall provide general care for the restored areas as soon as the sod has been laid (or seeded and mulched), and such care shall continue until final inspection and acceptance of the work. All restored areas shall be protected against traffic or other use by warning signs or barricades approved by the Town.

The Contractor shall mow the sodded and/or seeded areas with approved mowing equipment, depending upon climatic and growth conditions and the need for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they threaten to smother the species, they shall be mowed, and the clippings raked and removed from the area. When the surface has been damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the Engineering Director, and shall then be sodded, or seeded, as specified.

3.2.4 SODDING

All existing ornamental grass stands (commercial or private lawns) may be carefully taken up, protected, and replaced to their original condition or the Contractor may elect to install new sod of the same grass type. Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials, which might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the existing lawn species, and any vegetation more than 6 inches in height, shall

be mowed to a height of 3 inches or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than 2 inches.

After inspection and approval of the source of sod by the Engineering Director, the sod shall be cut with approved sod cutters to such a thickness that after it has been compacted, it shall have a uniform thickness of not less than 2 inches. Sod sections or strips shall be cut in uniform widths, not less than 10 inches, and in lengths of not less than 18 inches, but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The Contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the Contractor's control make storing necessary. In such cases, sod shall be stored in an unrolled condition, irrigated, and protected from exposure to air drafts and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, permission to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the Director, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches immediately prior to laying the sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitchforks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface, and ensure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Where the sod may be displaced during sodding operations, the workmen when replacing it shall work from ladders or treated planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sod sections. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately 1 inch below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaced around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges.

Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. Contractor shall water sodded areas a minimum of 1 inch of water, twice per week until re-established and once per week thereafter until work is accepted. In all cases, watering shall be done in a manner which will avoid

erosion from the application of excessive quantities and will avoid damage to the finished surface.

3.2.5 SEEDING

Following surface preparation as described in paragraph 3.1.A, *Excavation, Grading and Subgrade Preparation for Seeding/Sodding*, above, unless no soil test results are available, areas to be seeded shall be given an initial application of agricultural lime at a rate of at least 4,000 pounds per acre as well as fertilize and phosphate as shown on **Standard Detail 350.01**, all of which shall be thoroughly mixed with the soil. Dense or compacted soil areas and cut grade soil areas shall be ripped at than 6 inches of depth with a spring toothed ripper or similar equipment after finish grade but before tillage. Severely compacted surfaces shall be ripped to at least 12-inches of depth. No compaction soils shall be covered with soil fill until ripped. Finish grades on slopes shall be roughened parallel to contours to maximize surface storage and minimize runoff.

Upon completion of ground and soil preparation work, a grass seed mixture applied in accordance with **Standard Detail 350.01** shall be sown. Common Bermuda grass seed in hulled condition is permitted to be Spring planted from March 15th through June 30th and shall be in an unhulled condition from September 1st to April 1st. Centipede grass seed is permitted to be Spring planted from April 1st through July 15th and Fall planted from September 1st through February 28th. Target pH at 5.5 for centipede grass. See **Standard Detail 350.01** for other grass seed variations and planting times.

Substitutions for “Rebel” fescue will be considered acceptable only if the substituted fescue variety has no ratings less than “5” as determined by the USDA 1983 Tall Fescue Trails or more recent USDA trail data. No rye grass or other ground cover species shall be included in the seeding mixture. This shall be followed by placing a suitable cover of clean straw or approved equivalent mulch at the rate specified in **Standard Detail 350.01**. If straw is used as a temporary cover only, these rates shall be doubled or tripled depending upon average slope conditions.

A stand of grass shall be considered acceptable when area cover is at least 95%. The Contractor shall overseed, and otherwise maintain the grassed areas until the stand of grass has reached a uniform height of 3 to 4 inches and a state of uniform species maturity. The Contractor shall then top-dress the stand of grass with a minimum of 300 pounds per acre of 12-4-8 (4-1-2 or 3-1-2 ratio) fertilizer (or equivalent). Supply at least 1 lb. of nitrogen. Annual weed grasses and grain weeds shall not be considered part of the area cover, and seeding stands shall not be considered acceptable until the stand reaches a state of uniform post-seeding maturity for the specified species.

3.3 MULCHING

A. See **Standard Detail 350.01** for application rate. Mulch materials shall be spread uniformly by hand or machine to the designated areas. Anchor straw immediately after spreading to prevent displacement. All straw shall be stabilized by the application of an asphalt emulsion tackifiers or other approved binding material. Alternative stabilization methods such as Krimper, synthetic binders, chemical

mulches, mulch nettings, hydro-seeding or hydro-mulching may be considered on an individual basis.

When the mulch crimper or equivalent anchoring tool is used, it shall have straight blades and be the type manufactured expressly for and capable of firmly punching the mulch into the soil. Where the equipment can be safely operated, it shall be operated on the contour. Hand methods shall be used where equipment cannot safely operate to perform the work required.

Tackifiers shall be applied uniformly over the mulch material sufficient to bind/hold the straw, or they shall be injected into the mulch material as it is being applied. Mesh or netting stabilizing materials shall be applied smoothly, but loosely on the designated areas. The edges of these materials shall be buried or securely anchored using spikes or staples per the manufacturer's recommendations, as shown on the contract drawing details, or as directed by the Engineering Director.

B. **Maintenance**:

All mulches and soil coverings should be inspected periodically and after rainstorm events to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied. Nets and mats should be inspected after rainstorm events for dislocation or failure. If washouts or breakage occur, re-install netting or matting as necessary after repairing damage to the slope or ditch. Inspections should take place up until grasses are firmly established.

If straw mulching results in competing stands of grain, maintenance shall include mowing of the grain weed stand to a height of 4 inches prior to reaching a height of 10 inches. Grain weed stands shall not be considered part of the minimum 95% area cover. Unacceptable grass stands shall be overseeded, after aeration by spiker, at half the original rate, as many times as necessary to establish an acceptable stand.

3.4 HYDROSEEDING (Hydromulching)

A. When hydroseeding a prepared seed bed, as specified on the plans or when directed by the Engineering Director, the contractor shall submit the proposed mix of fertilizer, hydro-mulch, organic/nonpetroleum based tackifier, water, and seed to the Engineering Director for approval.

Hydroseeding is not to be performed on Residential lawn areas without consent or approval of the Engineering Director.

B. **Scope**: Hydroseeding shall include all equipment, materials, management, and labor necessary to prepare a seed bed, apply the seed mix, fertilizer, and mulch evenly immediately after the seedbed has been prepared and either as shown on the drawings, specified in the contact documents, or as directed and approved by the Engineering Director. Fertilizer, lime, mulch, and seed mix are to be seasonally adjusted to the season in which the hydroseeding application is to occur.

Materials:

1) **Fertilizer (Permenant Seeding)**: Minimum 400 pounds (maximum of 500 pounds) of 19-19-19 fertilizer shall be used per acre.

2) **Hydro-mulch**: Shall be cellulose or wood fiber based and shall be applied at 1,000 pounds per acre.

3) **Tackifier**: Shall be organic/ nonpetroleum based and shall be applied at the manufacturer's recommended rate per acre.

4) **Water**: Water shall not be acidic if non-potable water is used.

5) **Seed Mix**: The specified species and pure live seed amounts per acre shall be used. Seed shall be the last item to be placed into the tank and shall not remain in the hydro-seeder more than 4 hours. If legume inoculant is required, it shall be added to the tank with the seed. See **Standard Detail 350.01** for seasonal seed mix composition.

   Variations in seed mix, that differ from **Standard Detail 350.01**, particularly in areas that tend to be unmaintained or of low maintenance (e.g., stream banks and low maintenance areas with slopes greater than 3:1), that can achieve desired stabilization consistent with Climate Zone 3A, may be submitted to the Engineering Director for review and approval.

6) **Equipment**: A truck or trailer mounted hydraulic seeder shall be used with sufficient mixing capacity, pressure, and or hose to evenly apply the mulch, fertilizer, tackifier, and seed to all specified areas and as directed by the Engineering Director.

   On slopes less than or equal to 4:1 back blading may be used to prepare the soil to receive the seed under this specification. On slopes greater than 4:1, a tracked piece of equipment, preferably a crawler tractor (bulldozer), should be used to prepare a seedbed. Slopes should be tracked perpendicular to the slope and each track shall meet or overlap slightly with the adjacent track. This activity is incidental to hydroseeding unless seedbed preparation is covered by a separate bid item.

3.5 PLANTINGS

A. The scope of work for plantings shall include furnishing, delivery of plant trees, shrubs, vines, ground covers, bedding plants and seedlings at locations shown in the approved landscape plans or as otherwise directed by the Engineering Director, all in accordance with Section 1670 of the NCDOT *Standard Specifications for Roads and Structures,* latest edition.

B. The work of planting includes plant bed preparation, initial planting, staking and guying, if necessary, water for planting, plant establishment and replacement planting and maintaining

C. Perform the operations carefully to promote the continued life and healthy growth of all plants in their final location.

3.6 CLEANUP

A. **Disposal**: Remove surplus soil and waste material, unsuitable soil, trash, and debris and legally dispose of off-site.

END OF SECTION 02920

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STORMWATER DESIGN MANUAL

(Last Revised 10/18/24)

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Section 1 – INTRODUCTION & GENERAL GUIDELINES

(Last revised 10/18/24)

1.1 INTRODUCTION AND PURPOSE

These standards are meant to interpret and clarify the Stormwater Design Guidelines of the Town of Clayton, as described in Section 6.15 *Stormwater* of the Town of Clayton UDO, as applicable.

The Town's land use and development policies are discussed in broad terms as "livability", "public safety", and "variety of housing mix." The Town of Clayton's UDO, Section 4 *Land Uses*, contains community-wide goals and objectives which emphasize the existing character of the Town and its neighborhoods. The UDO also deals with the more specific concepts such as types of use, lot sizes, parking, zoning, and the like.

The Unified Development Code/UDO also requires that development and re-development activities properly manage and control stormwater runoff rates, volume, pollutants, and erosion and sedimentation as necessary to protect and safeguard the environment, property, health, safety, and welfare of the citizens within the Town's jurisdiction.

However, even these more specific terms can be interpreted in a variety of ways, especially where a specific location is being considered. Therefore, the Town of Clayton's Stormwater Design Manual has been prepared to help designers involved with land development in Clayton and its planning ETJ to understand, before they begin, what will most likely be acceptable in this jurisdiction. These standards are intended to compliment and supplement the general design guidelines included in the Code of Ordinances.

Specific design criteria set forth herein provide a ready reference of those practices and techniques acceptable to the Town. The Town also encourages design professionals to consider site characteristics closely in their design and to seek new and better practices and techniques for complying with Town development policies and regulations. If, in response to the characteristics of a particular site, innovative practices, and/or technological changes, a designer can make a valid case for application of standards that modify or substitute for the design standards contained herein, he or she is encouraged to do so.

Where alternative standards can be shown to conform to applicable policies and regulations, the Town may accept such alternative standards in lieu of the standards contained herein. Similarly, where a particular site is characterized by a large number or extent of impediments to developing land in compliance with applicable policies and standards, or where technological changes provide for practices and techniques that better ensure compliance, the Town itself may modify or substitute additional standards for the design standard continue herein.

These standards include deadlines for improvements. The Town Manager may allow extensions of deadlines provided these extensions:

1. Will not conflict with the intent of these standards and other land development regulations, and
2. Include a practical justification for an extension.

1.2 DISCLAIMER

To the best of their ability, the author(s) of this manual ensured that the material is accurate and reliable for use by others in the development of stormwater management plans and calculations. It is the final responsibility of the design professional to ensure that any methods, procedures and techniques specified in this manual are appropriate for a given situation. The Town of Clayton does not accept responsibility for any cost, loss, damage or injury resulting from the use of this manual.

1.3 COMPLIANCE

Compliance with these standards shall be required at the time the property is developed, whenever a major increase in intensity of use is created as determined by the Town Manager, or whenever a use change occurs as outlined in the Town of Clayton's Code of Ordinances.

The Town Manager may exempt modifications to existing developments from individual provisions of these standards where, in the opinion of the Town Manager, compliance with those provisions would create a practical hardship upon the property owner and where the modification does not increase a nonconformity.

The Design Manual, Standard Specifications, and Standard Details will be updated as necessary from time to time, and the revised page(s) will be available from the Engineering Department and on the Town's website at http://www.townofclaytonnc.org/

1.4 ENGINEERING DIRECTOR

The Engineer Director shall be responsible for interpretation and implementation of the stormwater management and design criteria for the Town of Clayton. Approval from other applicable agencies may be required.

1.5 TOWN OF CLAYTON STORMWATER MANAGEMENT

It is the policy of the Town of Clayton that all developed land within the Town Limits has adequate stormwater facilities and controls to ensure the protection and safety of life and property. The Town may accept stormwater management systems for maintenance if the system provides drainage for streets that have been accepted for maintenance by the Town provided such facilities adequately address the NPDES regulations and have been designed and constructed in accordance with the provisions of the Town of Clayton Code of Ordinances/UDO, and the latest revision to the following documents which are herein made part of this manual by reference:

- The North Carolina *Erosion and Sediment Control Planning and Design Manual*.
- NCDEQ Division of Energy, Mineral, and Land Resources, Stormwater Design Manual.

- Town of Clayton *Manual of Specifications, Standards, and Design*.

1.6 PERMITS

A. **Plan approvals, Permits**: Prior to commencing construction, all plan approvals and applicable permits shall be obtained. A preconstruction conference with the Town Inspector must also be held prior to commencing any construction.

B. **Encroachment Permits:** An encroachment permit will be required from any Contractor or Developer wishing to excavate or place storm drainage structures on either a NCDOT or Municipal public right-of-way.

C. **Pavement Cuts**: Pavement cuts in streets shall be repaired in accordance with the specific requirements of public agency on whose street or roadway the utility is being placed, as well as any other applicable requirements dictated in the approved encroachment permit. Open cut crossings shall otherwise adhere, as applicable, to specification Section **02275, *Trenching, Backfilling & Compaction of Utilities***.

D. Developer must obtain all other State and Local permits, as applicable (Air Quality, Erosion and Sedimentation Control, Zoning, etc.)

E. **Plan Review and Observation Fees:** All plan review and observation fees must be paid prior to approval of project. Refer to the current Town fee schedule for applicable fees.

F. Approval of Stormwater Management Plans and Calculations by the Town of Clayton does not complete the Town of Clayton review process. All other applicable Town Departments, State, and Federal agencies must also approve the plan as warranted. It shall be the sole responsibility of the Owner/ Developer/ Designer to acquire all applicable approvals.

1.7 WETLANDS, WATERSHEDS, BUFFERS

All stream impacts by crossings, pipe placement, excavation, regrading, clearing, maintenance, etc., shall be subject to the applicable US Army Corps of Engineers 404 and NCDEQ DWQ 401 permit requirements in affect at the time of the permit application. Construction within jurisdictional wetlands and buffers shall conform to the applicable permit requirements of the issuing agency.

1.8 EROSION AND SEDIMENTATION CONTROL AND NPDES MONITORING, CONTROLS, AND LIMITATIONS FOR PERMITTED DISCHARGES

The Project Engineer shall submit a sedimentation and erosion control plan to the Town and obtain all necessary construction permits. The Contractor shall follow both local and state requirements regarding sedimentation and erosion control. Construction methods shall minimize sedimentation and erosion.

It is the Contractor's responsibility to periodically monitor the Stormwater Discharge Outfall points at the specified frequency and maintain reports as outlined in these specifications.

A. Final Limitations and Controls for Stormwater Discharges

During the period beginning on the effective date of the permit and lasting until expiration, the Owner (Permittee) is allowed and authorized to discharge stormwater associated with construction activity. Such discharges shall be controlled, limited, and monitored as specified below.

1. The Contractor shall implement the Erosion & Sedimentation Control plan, which has been approved by the Town. The approved plan is considered a requirement or condition of the general NPDES permit. Deviation from the approved plan, or approved amendment to the plan, shall constitute a violation of the terms and conditions of this general permit except that deviation from the approved plan will be allowed:

   a. To correct an emergency situation where sediments are being discharged off the site, or

   b. When minor modifications have been made for the purpose of improving the performance of the erosion and sedimentation control measures and notification of the minor modification has been made to the NCDEQ.

   Such a deviation from the approved plan shall be noted on the approved plan maintained at the job site. During active construction, a copy of the approved plan shall be maintained on the site.

2. Equipment utilized during the construction activity on a site must be operated and maintained in such a manner as to prevent the potential or actual pollution of the surface or ground waters of the state. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not be discharged onto the ground or into surface waters. Spent fluids shall be disposed of in a manner so as not to enter the waters, surface, or ground of the state and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in a manner so as not to allow their entry into the waters, surface or ground, of the state.

3. Herbicide, pesticide, and fertilizer usage during the construction activity shall be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act and shall be in accordance with label restrictions.

4. All wastes composed of building materials shall be disposed of in accordance with North Carolina General Statutes, Chapter 130A, Article 9 – *Solid Waste Management*, and rules governing the disposal of solid waste (North Carolina Administrative Code Section 15A NCAC 13B).

5. The Contractor, for the Permittee, shall control the management and disposal of litter and sanitary waste from the site such that no adverse impacts to water quality occur.

B. **NCG01 General Permits**

Contractor and developer to abide by all requirements and conditions of NCG01 General Permit as part of NPDES compliance.

1.9 EASEMENTS

Drainage easements are required for all public and private drainage systems which carry water from the Town right of way or Town owned property. This includes commercial developments with out-parcels, phased development and other developments with surrounding land under the same ownership at the tract being developed.

1.9.1. Public Drainage Easement Maintenance

Property owners are responsible for routine grounds maintenance such as grass mowing and trash or debris removal and should ensure that systems are kept free of yard waste such as grass clippings, tree trimmings, and leaves that may block the flow of water. No structures, fences, walls, HVAC equipment, trees, shrubs, hardscapes or other items that obstruct maintenance vehicles may be installed within drainage easements (see paragraph 7.2.5 *Final Plat Notes*). The Town maintains the drainage system and structures within the easement to allow for proper function of the system. The Town will clean the ditch if it is blocked by natural causes.

The Town may deny acceptance of any drainage system that does not provide the proper legal authority for access, operation and maintenance of the system.

1.9.2. Drainage Easements Requirements:

A. For all culverts, all new or existing open channels or watercourses that carry water from public rights-of-way or convey water from adjoining property across the developing property. Width of the easements shall be per Table 1.2 below.

Table 1.2
Drainage Easement Widths for Culverts

Description	Min. Easement Width
Up to 24”	20 ft.
36” to 48”	30 ft.
Larger than 48”	Width of Pipe + 30 feet
Open Channels	Top of Bank Width + 20 ft.

B. For all stormwater control measures, the SCM shall be located in a stormwater easement with a minimum width of 15 feet beyond the top of bank or toe of slope and as necessary to provide access for maintenance. The SCM system includes the side slopes, forebay, riser structure, SCM device, basin outlet, dam embankment and emergency spillway.

C. For all new or existing open channels or watercourses with peak flows of 15 cubic feet per second or more for the 10-year storm.

D. At other locations deemed appropriate by the Engineering Director or Stormwater Administrator.

1.9.3. Additional Easement Requirements:

A. Appropriate drainage easements must be secured prior to the submission of the construction plat if the easement(s) is entirely or partially located offsite.

B. Access easements, dedicated to the Town, shall be provided for access and repair of velocity dissipaters, headwalls, and other structural portions of the drainage system located outside of the right-of-way, which are immediately adjacent to and directly associated with the Town owned portion of the drainage system. These easements are requested to allow Town staff access to repair and maintain those drainage facilities located immediately adjacent to the right-of-way, which would endanger the roadway should they fail.

C. Adequate easements shall be provided to allow access for construction equipment, taking into consideration the limitations that may be imposed by embankment slopes or other obstacles.

D. Drainage easements containing only storm drainage facilities should be centered over the culvert or watercourse.

E. All drainage easements should be recorded based on field surveys, following construction, to ensure that the drainage structure or watercourse is centered within the easement (unless specifically offset). Where this is not possible, a note shall be added to recorded plats establishing that easements are to be centered over the pipe or channel.

F. Consideration shall be given for deeper cuts (generally greater than 12”) by including an additional construction easement (usually 10’-20’).

G. All drainage easements shall be designed to tie into existing easements, existing watercourses or to other appropriate locations when possible.

H. Easements shall be fully accessible (in slope and width) by rubber-tired vehicles in their entirety.

I. Drainage easements for ditches that convey stormwater across lot lines shall be provided. Private drainage easements which cross property lines are the responsibility of HOA to maintain.

J. Public drainage easements shall be located in open space to the maximum extent practicable.

K. Public drainage easements should NOT be combined with other utility easements. The easements may overlap but the physical utility shall not encroach on the easement of another utility.

L. **Final Plat**: The following notes shall be placed on all Final Plats that require drainage easements or SCMs:

i. “The drainage easements and stormwater control measures shown hereon are required on the property to meet Town and state stormwater regulations. Property Owner may be subject to enforcement actions if the maintenance easement is obstructed or stormwater control measure is removed, relocated or altered without prior Town approval.”

ii. “No structures, fences, walls, HVAC equipment, trees, shrubs, hardscapes or other items that obstruct maintenance vehicles may be installed within drainage easements. Per the Operation and Maintenance Agreement recorded in the Register of Deeds, the property owners grant the Town the right, privilege and easement across the property for the purpose of inspecting, monitoring, etc., the stormwater control measure as needed. Note that maintenance of the drainage easement is the responsibility of the underlying property owner, who shall maintain the easement to allow positive conveyance of stormwater.”

Section 2 – HYDROLOGIC ANALYSIS

The purpose of this section is to establish standard design procedures and criteria for the performance of hydrologic analyses in the Town of Clayton. Development and re-development within the Town of Clayton jurisdiction is required to manage stormwater in accordance with Town UDO. This section of the Design Manual provides information on the design and application of acceptable means and measures to comply with the requirements of that Ordinance.

Acceptable stormwater management practices include those found in this Design Manual and in the latest edition of the NCDEQ Division of Energy, Mineral, and Land Resources Stormwater Design Manual, which is herein made part of this manual by reference. The Town reserves the right to modify, amend or otherwise change these accepted practices as may be necessary to achieve stated stormwater management goals.

2.1 HYDROLOGIC DESIGN

Hydrologic design includes evaluation of impacts that development has on stormwater runoff. The evaluation involves selecting the required design storm (Table 2.1) and using accepted hydrologic methodology to design storm drainage infrastructure, stream crossings, detention/retention facilities, etc., as necessary to meet the applicable requirements and the performance standards of the Town's Land Use Plan. Designers must evaluate the impacts of proposed stormwater management practices both on-site and on adjacent properties, structures, and roadways.

Table 2.1 lists return periods for determining design storm and check storm discharges for different facility types. The check storm analysis should indicate that surcharge or overflow discharges will be conveyed in a controlled manner that will not cause public health or safety risk.

Table 2.1
Design and Check Storms

FACILITY	DESIGN STORM (SCS 24-HOUR DURATION)	CHECK STORM (SCS 24-HOUR DURATION)
Arterial Roadways	25-year	100-year
Collector streets	25-year	100-year
Local Roadways	10-year	25-year
Bridges/Box Culverts, Stream Crossings[1]	50-year	100-year
Open channels – normal runoff	10-year	25-year
Cross-drainage and drainage areas >1 square mile	25-year	-
Adjacent to building structures w/ flooding potential	100-year	-
SCM Structures/Non-structures	Per NCDEQ Stormwater Design Manual	
Drainage facilities for residential development accepting lot runoff only (no roadway discharge)	2-year	10-year
Drainage Facilities providing diffuse flow	10-year	25-year
Drainage Facilities for Parking Lot	10-year	25-year
Spillway structure for impoundment (i.e. detention/retention facilities)	25-year	100-year
Curb & gutters, curb & gutter inlets	2-year, 5 minute TC	-

[1] For regulatory Floodways, the Design Storm is the 100-year return period.

Where conflicts arise between applicable NCDEQ and Town design storm requirements, the more restrictive of the two shall govern.

Table 2.2

I-D-F Table

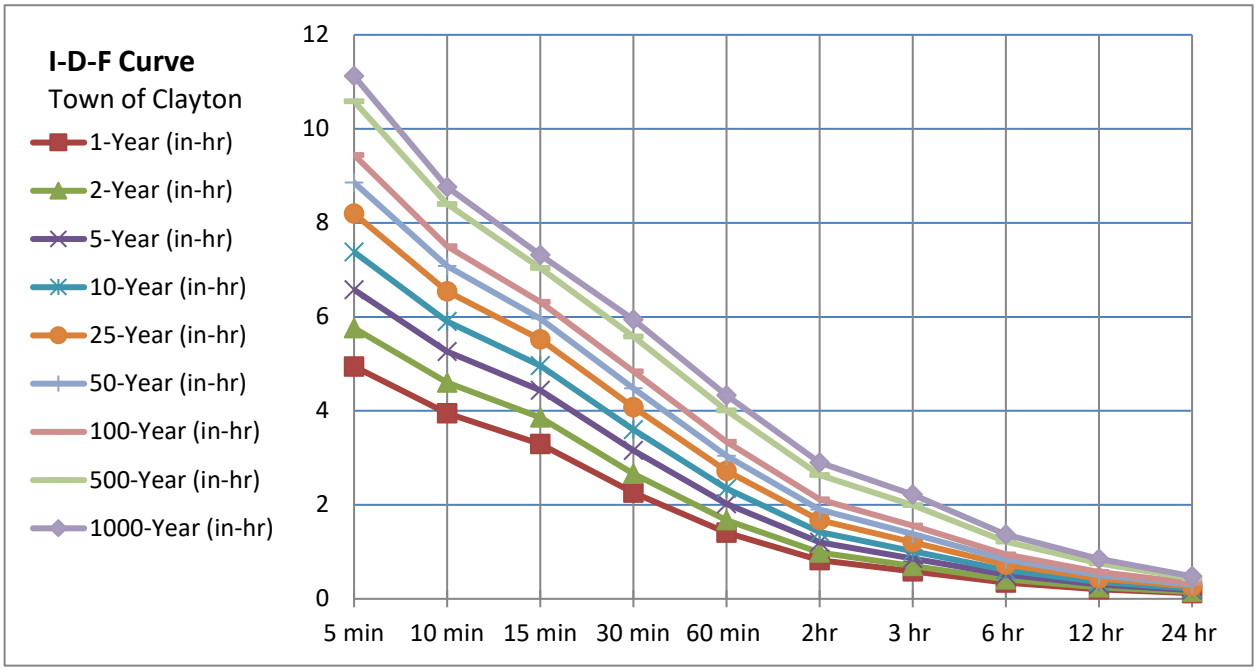
Return Period (years)	Duration									
	5 min	10 min	15 min	30 min	60 min	2hr	3 hr	6 hr	12 hr	24 hr
1-Year (in-hr)	4.94	3.95	3.29	2.26	1.41	0.83	0.58	0.35	0.21	0.12
2-Year (in-hr)	5.76	4.60	3.86	2.66	1.67	0.99	0.70	0.42	0.25	0.15
5-Year (in-hr)	6.58	5.26	4.44	3.16	2.02	1.21	0.86	0.51	0.30	0.19
10-Year (in-hr)	7.38	5.90	4.96	3.60	2.35	1.42	1.01	0.61	0.36	0.22
25-Year (in-hr)	8.20	6.54	5.52	4.08	2.72	1.68	1.21	0.73	0.44	0.26
50-Year (in-hr)	8.86	7.08	5.96	4.48	3.04	1.90	1.38	0.84	0.50	0.30
100-Year (in-hr)	9.44	7.50	6.32	4.84	3.34	2.12	1.56	0.95	0.57	0.34
500-Year (in-hr)	10.58	8.40	7.04	5.58	4.01	2.64	1.99	1.22	0.75	0.43
1000-Year (in-hr)	11.12	8.76	7.32	5.94	4.33	2.90	2.22	1.37	0.85	0.48

Source:

Point Precipitation Frequency Estimates From NOAA Atlas 14

Clayton, North Carolina Latitude: 35.6408º Longitude -78.4663º W 300 feet

Station: Clayton 3W: Site ID: 31-1820



Section 3 – PIPE GEOMETRIC DESIGN & MATERIALS

3.1 TOWN OF CLAYTON STORM DRAINAGE PIPE CRITERIA

The following criteria apply to storm drainage pipe under public streets within public rights-of-way, and/or within public drainage easements.

3.2 PIPE SIZE

The minimum pipe inside diameter is 15 inches.

3.3 PIPE MATERIAL – APPLICATIONS

A. **General**: Use pipe type and placement conditions in accordance with Town **Paragraph 2.1 of Specification Section 02630**.

3.4 PIPE GRADE

A. **MINIMUM PIPE SLOPE:** It is desirable to maintain a self-cleaning velocity in the storm drain to prevent deposition of sediments and subsequent loss of capacity. For this reason, storm drains should be designed to maintain full-flow pipe velocities of 3 fps or greater. This criteria results in a minimum flow velocity of 2 fps at a flow depth equal to 25% of the pipe diameter. Minimum slopes required for a velocity of 3 fps can be computed using the form of Manning's equation given below. Alternately, the "minimum" pipe slopes shown in Table 3.1 can be used.

$$S = 6.4\left(\frac{nV}{D^{0.67}}\right)^2 \qquad (3.1)$$

$$S = 6.4\left(\frac{NV}{D^{0.67}}\right)^2$$

Table 3.1[1]
Minimal Pipe Slopes

D (in)	n =		
	0.012	**0.013**	**0.024**
12	0.0037	0.0043	0.0147
15	0.0027	0.0032	0.0109
18	0.0021	0.0025	0.0086
24	0.0015	0.0017	0.0058
30	0.0011	0.0013	0.0043
36	0.0008	0.0010	0.0034
42	0.0007	0.0008	0.0028
48	0.0006	0.0007	0.0023
54	0.0005	0.0006	0.0020
60	0.0004	0.0005	0.0017
66	0.0004	0.0004	0.0015
72	0.0003	0.0004	0.0013
84	0.0003	0.0003	0.0011

[1]Slopes shown in table are based on 2 fps with flow depth at 25% of pipe diameter. Given slopes will yield 3 fps at full flow.

B. **ACCEPTABLE VARIATION IN SLOPE:** The maximum permitted grade variation in post-construction pipe grade shall be -10% of the design grade. The computation of the post-construction pipe grade shall be based on a post-construction field survey. The grade shall be computed by taking the actual difference between the invert in and invert out of the pipe run divided by the actual pipe length. Pipe runs laid at less than the approved design grade must be removed and re-laid. The requirement to verify the pipe grades shall be at the Engineering Director's discretion. Verification of grades should be completed when installed slopes are questionable or in drainage locations where pipe slopes or installation of pipes are critical.

Example:

Design Grade: 0.005 ft//ft or 0.5%

Field Check of Grade:

Surveyed Invert in =	*96.50*		
less Surveyed Invert out =	*96.04*		
Difference =	*0.46*	*ft*	
Actual Pipe Run Length =	*100*	*ft*	*(not measured C-C of Boxes!)*
Slope =	$\frac{0.46}{100}$	=	*.0046 or 0.46%*

Variation Check:

Design Grade	*0.50%*
Actual Grade	*0.46%*
Difference:	*0.04%*

Allowable deviation is 10% of Design Grade = 0.10 x 0.50% = 0.05%

Allowable deviation of 0.05% > 0.04% allowable deviation…VARIATION OK!

3.5 ENERGY LOSSES

Energy losses in pipe runs and structures must be estimated to overcome changes in momentum or turbulence at outlets, inlets, bends, transitions, and junctions in addition to the standard pipe friction loss. The following are the minimum standards to help determine the energy loss in the system for catch basins, drop inlets and junction boxes.

Table 3.2a
Minimum Structure Invert Drop

DEFLECTION ANGLE OF EFFLUENT LINE	DROP[1]
0-45º	0.1 ft or value computed from Table 3.2c
45º-90º	0.2 ft.
>90º	Only with detailed calcs showing headwater/tailwater conditions on influent/effluent pipes and impact on pipe, min drop > than the effluent pipe diameter

CHANGE IN PIPE SIZE	DROP[1]
Increase in pipe size	Crowns of pipe to match
Decrease in pipe size	Submit detailed study on effect of effluent line. Indicate any special provisions for maintenance resulting from increased velocity, headwater, etc.

[1]Drops of less than that shown may be approved with the approval of the Engineering Director or Stormwater Administrator.

Table 3.2b
Inlet Coefficients
Outlet Control, full or partly Full Entrance Head Loss

$$H_e = K_e \frac{v^2}{2g}$$

Type of Structure and Design of Entrance	Coefficient K_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (grove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
[1]End-section conforming to fill slope	0.5
Beveled edges, 33.7º or 45º bevels	0.2
Side or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
[1]End section conforming to fill slope	0.5
Beveled edges, 33.7º or 45º bevels	0.2
Side or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Round on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30º to 75º to barrel	
Square-edged at crown:	0.4
Crown edge rounded to radius of ½ barrel dimension or beveled top edge	0.2
Wingwall at 10º to 25º to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Note: [1]"End-section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections incorporating a closed taper in their design have a superior hydraulic performance.

Ref: Norman, J. M., Houghtalen, R. J., and Johnston, W J., 1985. *Hydraulic Design of Highway Culverts*. HDS No. 5, Federal Highway Administration, McLean, VA.

Table 3.2c
Head Loss Coefficients

$$H_{ah} = K_{ah}\left(\frac{v_o^2}{2g}\right) \quad \mathrm{H_{ah}} = \mathrm{K_{ah}}\left(\frac{\mathrm{v_o}^2}{2\mathrm{g}}\right)$$

Structure Configuration	K_{ah}
Inlet – straight run, square edge	0.5
Inlet – angled through	
90º	1.50
60º	1.25
45º	1.10
22.5º	0.70
Manhole – straight run, min	0.15
Manhole – angled through	
90º	1.00
60º/120º	0.85
45º/135º	0.75
22.5º/157.5º	0.45

Ref: HEC No. 22, Table 7-5

3.6 PIPE ALIGNMENT:

A. **Run Length**: The length of individual storm drain runs is dictated by storm drainage system configuration constraints and structure locations. Storm drain system constraints include inlet locations, maintenance equipment limits, access hole and junction box locations, etc. Where possible, storm drains should be straight between access boxes and shall not exceed the maximum run length between access boxes shown in Table 3.3, unless otherwise approved by the Engineering Director or Stormwater Administrator.

Table 3.3
Maximum Pipe Run Length Between Structures

PIPE MATERIAL	SIZE (inches)	MAXIMUM RUN LENGTH (feet)
Reinforced Concrete Pipe	15 to 24	300
	30 to 36	400
	42 and 54	500[1]
	60 and larger	1000[1]
Double walled HDPE or HP PP Pipe	15 to 48	425
Corrugated Aluminum	Same criteria as RCP	

[1]If catch basin spacing exceeds 300 feet, calculations justifying increased spacing shall be provided. See also Curb Inlet Design – Gutter Spread, Section 10.4 and Curb Inlet Design, Section 4.6.

[2]This length may be exceeded with approval by the Engineering Director on a case-by-case basis.

B. **Alignment:** To reduce impact to utilities, all storm drain lines shall follow the curb line as much as practical (i.e. none behind curb or in street in curves).

C. **Curved Pipe**: When approved by the Engineering Director or Stormwater Administrator, curved storm drains are permitted where necessary to conform to the street layout or avoid obstructions. Long radius bends, with beveled ends, are available from supplies and are the acceptable means of changing direction in pipes larger than 48 inches in diameter. The radius of curvature specified should coincide with the standard curves available from the supplier for the pipe diameter and class being used or otherwise fabricated by the supplier to conform to the radius required and approved by the Town.

Deflecting non-beveled standard pipe joints to obtain the necessary curvature is not permitted.

Pipes sizes 48 inches and smaller should not be designed with curves.

D. **Pipe Bedding:** Bedding for culverts within public rights-of-way shall conform to Storm Drainage Section 02630, 3.1.2B (RCP) and Section 02630.1.3.C as applicable.

3.7 STRUCTURE PLACEMENT REQUIREMENTS:

A. **Pipes 48-inches or less**:

1. At vertical changes in grade
2. At horizontal changes in direction
3. At maximum run lengths shown in Table 3.3. If a catch basin is not required, structure shall be a manhole junction box. No blind junction boxes are permitted (manhole access must be provided).
4. At all junction of 2 or more pipes
5. At all catch basins

B. **Pipes greater than 48 inches but less than 66 inches**:

1. Same as for Pipes 48 inches or less except:
   a. *When approved by the Engineering Director or Stormwater Administrator*, the horizontal change in direction is to be effected by a horizontal curve as an alternate means of changing pipe direction and the maximum run length is less than that required in Table 3.3. However, the Engineering Director or Stormwater Administrator, at their discretion, may approve an integral riser for manhole access along a curve as a substitute for a manhole junction box should the curve length exceed the maximum permitted run length.

C. **Pipes 66 inches in diameter and larger**:

1. Same as for Pipes greater than 48 inches but less than 66 inches except:
   a. The main drain line and integral risers for a catch basins and manholes, inclusive of steps in the riser section only, shall be designed and

manufactured to carry the weight of the riser, grate and frame and any superimposed traffic loads. Risers shall be eccentric. If the main slope exceeds 1%, a standard manhole or manhole junction box will be required to be provided.

3.8 PIPE TERMINAL ENDS

A. Headwalls/endwalls shall be provided for pipes with diameters larger than 36 inches unless alterative end treatments are approved by the Engineering Director or Stormwater Program Administrator. Flared-end sections may be used with pipes 36-inch or less in diameter.

B. This requirement is also applicable at driveway culverts.

3.9 PIPE CAMBER IN ROADWAY FILL EMBANKMENTS

A roadway embankment exerts more load on the foundation at the center of the embankment than at the toe of the slope. Consequently, more settlement will occur in the center area of the embankment fill which will yield a corresponding settlement of the conduit. To avoid sag vertical deflection in the longitudinal pipe section, the bedding profile can be cambered longitudinally. The upstream half of the pipe may be laid on almost a flat grade and the downstream half on a steeper grade. The mid-ordinate of the curve should be determined by a Geotechnical Engineer.

3.10 COVER

Both the minimum and maximum cover must be considered in the design of storm drainage systems. Minimum cover limits are established to ensure the conduits structural stability under live and impact loads. With increasing fill heights, dead load becomes a controlling factor.

For the Town of Clayton, cover requirements shall conform to Table 3.4. In cases where these criteria cannot be met, the storm drains should be evaluated to determine if they are structurally capable of supporting the imposed loads provided the reduced cover is allowed by the Engineering Director or Stormwater Administrator.

Maximum cover limits are controlled by fill and other dead loads. Maximum permitted height of cover is shown below in Table 3.4. For heights exceeding these limits, the Engineer shall submit to the Engineering Director or Stormwater Administrator calculations showing the bury depth is satisfactory. The calculations shall consider pipe bedding, trench width, bury, pipe class, soil arching, live and/or dead loads as applicable, and material (flexible or rigid), etc.

Table 3.4
Maximum Cover Depths

Conditions	Minimum Cover Depth (ft)	Maximum Cover Depth
Roadways	*	*
Residential Driveways	1	*
Commercial Driveways	*	*
Non-traffic bearing	1	*
PP & HDPE	*	*
Corrugated Aluminum	*	Submit supporting documentation*

*See NCDOT *Pipe Material Selection Guide* (202 or latest revision) for minimum and maximum bury depths for RCP, CSP, CAAP, and Double Walled PP (gray) and HDPE Pipe

3.11 STRUCTURES IN RELATION TO STREAMS/FLOODPLAINS:

Storm drainage manholes, pipe, or other drainage structures shall be located so that they will not interfere with free discharge of the flood flows of the stream to which they are proposed to tie. Portions of manholes above grade subject to hydrodynamic forces of flooding shall be designed to resist the flood forces with a safety factor of 2.5. Considerations shall be given for impact from debris.

Section 4 – CULVERT DESIGN

The purpose of this section is to establish standard procedures and criteria for Culvert Design for the Town of Clayton.

4.1 INTRODUCTION

A drainage system shall be designed and constructed by the developer to provide for the proper drainage of the surface water of the development and the drainage area of which it is part. The storm drainage system shall follow existing topography as nearly as practical. Additional design information shall be submitted to indicate that provision has been made for the adequate disposal of surface water without any damage to the developed or undeveloped land downstream or below the proposed development. A copy of all drainage computations shall be submitted, clearly stating any assumptions made.

The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off-site areas, assuming ultimate development in accordance with the current zoning regulations and the Land Use Plan.

4.2 PIPE CULVERT DESIGN - GENERAL

Private drainage culverts and public drainage culverts within a subdivision or site development sub-basin shall be designed according to this section.

Pipe culverts shall be aligned parallel to the longitudinal axis of the channel, as much as possible, to ensure maximum hydraulic efficiency and to minimize erosion. In areas where a change in alignment is necessary, the change shall be accomplished upstream of the culvert in the open channel. Appropriate erosion protection shall be provided.

Pipe culverts crossing beneath the roadway shall be designed to span from ditch line to ditch line.

4.3 ROADWAY DRAINAGE SYSTEM

The road storm drainage system shall serve as the primary drainage system and shall be designed to carry roadway, adjacent land, and building stormwater drainage. No stormwater shall be permitted into the Town's sanitary sewer system.

4.4 DESIGN FREQUENCY

The design criteria for storm drainage shall be based upon the data prepared by NC Department of Transportation *Guidelines for Drainage Studies and Hydraulic Design*, latest revision, USDOT Federal Highway Administration *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, the *NC Erosion and Sediment Control Planning and Design Manual,* NCDEQ Division of Water Resources *Stormwater Design Manual,* the SCS *National Engineering Field Manual for Conservation Practices*, or other acceptable calculation procedures.

The minimum design frequency for culverts shall conform to Table 2.1, Section 2, Hydrologic Analysis.

4.5 HYDRAULIC DESIGN OF CULVERTS

4.5.1. FLOW TYPE ASSUMPTIONS

The design procedures presented here assume that flow within each storm drain segment is steady and uniform. This means that the discharge and flow depth in each segment are assumed to be constant with respect to time. Also, since storm drain conduits are typically prismatic, the average velocity through a segment is considered to be constant.

In actual storm drainage systems, the flow at each inlet is variable, and flow condition are not truly steady or uniform. However, since the usual hydraulic methods employed in storm drain design are based on computed peak discharges at the beginning of each run, it is a conservative practice to design using the steady uniform flow assumption.

4.5.2. OPEN CHANNEL VS. PRESSURE FLOW

Two design philosophies exist for sizing storm drain under the steady uniform flow assumption. The first is referred to as open channel or *gravity flow design*. To maintain open channel flow, the segment must be sized so that the water surface within the conduit remains open to atmospheric pressure. For open channel flow, flow energy is derived from flow velocity (kinetic energy), depth (pressure), and elevation (potential energy). If the water surface through the conduit is to be maintained at atmospheric pressure, the flow depth must be less than the height of the conduit.

Pressure flow design on the other hand, requires that flow in the conduit be at a pressure greater than atmospheric. Under this condition, there is no exposed flow surface within the conduit. In pressure flow, flow energy is again derived from flow velocity, depth, and elevation. The significant difference here is that the pressure head will be above the top of the conduit, and will not equal the depth of flow in the conduit. In this case, the pressure head rises to a level represented by the hydraulic grade line.

The question of whether open channel or pressure flow should control design has been debated among various highway agencies. For a given flow rate, design based on open channel flow requires larger conduit sizes than those based on pressure flow. While it may be more expensive to construct storm drain systems design based on open channel flow, this design procedure provides a margin of safety by providing additional headroom in the conduit to accommodate an increase in flow above the design discharge. This factor of safety is often desirable since the methods of runoff estimation are not exact, and once placed, storm drains are difficult and expensive to replace.

However, there may be situation where pressure flow design is desirable. For example, on some projects, there may be adequate headroom between the conduit and inlet/access hole elevation to tolerate pressure flow. In this case, a significant cost savings may be realized over the cost of a system designed to maintain open channel flow. Also, in some cases it may be necessary to use an existing system which must be placed under pressure flow to accommodate the proposed design flow rate. In instances such as these, there

may be advantages to making a cursory hydraulic and economic analysis of a storm drain using both design methods before making a final selection.

Under most ordinary conditions, it is recommended that storm drains be sized based on a gravity flow criteria at flow full or near full. Designing for full flow is a conservative assumption since the peak flow actually occurs at 93% full. However, where shallow bury or headroom is critical and/or where the maximum permitted headwater over a street storm inlet must be verified not to exceed the given criteria, the system may have to be analyzed based on pressure flow criteria. However, the Town of Clayton will accept either method.

An example of pressure flow and gravity flow are shown in Section 10.3.

4.5.3. HYDRAULIC GRADE LINE (HGL)

For enclosed piping systems, the HGL shall not exceed the crown of the pipe elevation for the 10-year, 24-hour storm event.

The HGL shall not exceed the top of structures or the gutter line elevation, as applicable, for the 25-year, 24-hour storm event.

4.5.4. METHODOLOGY

The Town of Clayton uses the design procedures of Hydraulic Design Series No. 5 (*HDS-5*) for the design of pipe culverts. *HDS-5* was designed to analyze flow in pipes using many different variables. The procedures in the *Urban Drainage Design Manual*, HEC-22, also may be utilized. HEC-22 utilizes many of the same procedures in pipe culvert analysis with references to HDS-5.

4.6 CURB INLET DESIGN

Curb storm drainage inlets shall be provided at intervals along roadways. Where these inlets connect to storm sewers, a catch basin shall be installed with the inlet.

NCDOT *Guidelines for Drainage Studies and Hydraulic Design*, latest revision, or the USDOT Federal Highway Administration *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, Chapter 4, as applicable, shall be used for curb inlet design.

For curb and gutter inlets, a minimum intensity of 2 year storm at 5 minute time of concentration shall be used in all computations (from Table 2.1). Table 2.1 lists return periods for determining design storm and check storm discharges for different facility types.

Inlet spacing and sizing shall be adequate to limit the spread of water to ½ the travel lane into the roadway. The travel lane is the outside lane and does not include the gutter section. Allowances shall be given for the potential of clogging at sumps. Due to clogging characteristics, the use of slotted drains alone are not recommended in sag locations. See also Table 3.3, Maximum Pipe Run Length Between Structures and Curb Inlet Design – Gutter Spread, Section 10.4.

Table 4.6
Recommended Clogging Factors in Sump Condition[1]

Number of Units	Grated Inlet	Curb Opening Inlet
1	0.50	0.12
2	0.35	0.08
3	0.25	0.05
4	0.15	0.03

Storm drainage inlets will be placed so that crosswalks will not be flooded during the design storm intensity.

Further information on **curb inlet design** and **gutter spread** is found in Section 10.4.

4.7 EROSION CONTROL

All erosion and sediment control measures shall be designed in accordance with the *NC Erosion and Sediment Control Planning and Design Manual*, and the NCDEQ Division of Energy, Mineral and Land Resources *Stormwater Design Manual*. These manuals contain valuable information and tools for developing plans to minimize soil erosion and prevent sedimentation pollution associated with land-disturbing activities.

Erosion and Sedimentation Control is under the jurisdiction of the Town of Clayton. Refer to the Town of Clayton UDO, section 6.14 *Soil Erosion & Sedimentation Control* for applicable requirements.

All individuals that obtain a state or locally approved erosion and sedimentation control plan that disturbs one acre or more of land are required by the U.S. Environmental Protection Agency to obtain coverage under the N.C. Department of Environmental Quality Construction General Permit No. NCG010000 (NCG01). The requirements in NCG01 for temporary or permanent ground cover may differ from the ground cover, or stabilization, requirements in this chapter. It is the responsibility of the person conducting the land disturbing activity to ensure compliance with the NCG01.

[1] Table 10.1, Urban Hydrology and Hydraulic Design, James C. Y. Guo, Water Resources Publication, LLC, (Observed Conditions).

Section 5 – OPEN CHANNEL DESIGN

The purpose of this section is to establish standard procedures and criteria for Open Channel Design for the Town of Clayton.

5.1 INTRODUCTION

Open channels, where allowed, shall be designed according to the following criteria. The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off-site areas, assuming ultimate development in accordance with the current zoning regulations and the Comprehensive Land Use Plan.

5.1.1. OFF-ROAD DRAINAGE SYSTEM

The design of the off-road drainage system shall include the watershed affecting the development and shall be extended to a watercourse or drainage way adequate to receive the storm drainage. Swales and channels shall be constructed true to definition and shall join the contours of the surrounding topography in such a manner that will create a gently rolling natural appearance. Side drainpipes along side property lines shall be extended to the back drainage easement.

When the drainage system is outside of the road right-of-way, the subdivision shall make provision for dedicating an easement to the Town of Clayton to provide for the future maintenance of said system.

5.1.2. REQUIRED DOCUMENTATION FOR OPEN CHANNEL DESIGNS

The following information must be submitted to the Town of Clayton for the design of open channels, but is not limited to the following:

A. Vicinity Map: A vicinity map of the site and subject reach.

B. Site Map: A detailed map of the area and subject reach.

C. Drainage Map: A drainage map showing existing and proposed drainage area boundaries along with all sub-area delineations and all areas of existing or proposed development.

D. Discharge Calculations: Discharge calculations specifying the methodology and key assumptions used, along with computed discharges at key locations. The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off site areas, assuming ultimate development in accordance with the current zoning regulations and the Land Use Plan.

E. Hydraulic Calculations: Hydraulic calculations specifying the methodology used. All assumptions and values of design parameters must be clearly stated.

F. Plotted Cross-Sections: Typical existing and proposed cross-sections.

G. When sizing channels, consideration shall be given to ultimate build out. Base flow may require incorporation of a trapezoidal low flow channel in the main trapezoidal ditch section.

5.2 OPEN CHANNEL DESIGN

The proper hydraulic design of a channel is of primary importance in ensuring that flooding, sedimentation and erosion problems do not occur.

Equations and nomographs are shown in Section 10.5 Open Channel Design for the convenience of the designer.

The following general criteria should be used in the design of open channels:

5.2.1. DESIGN FREQUENCIES FOR OPEN CHANNEL DESIGN

The design criteria for storm drainage shall be based upon the data prepared by NC Department of Transportation *Guidelines for Drainage Studies and Hydraulic Design*, USDOT Federal Highway Administration *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, the *NC Erosion and Sediment Control Planning and Design Manual*, NCDEQ Division of Energy, Mineral, and Land Resources *Stormwater Design Manual*, or other acceptable calculation procedures.

All open channels in the Town of Clayton shall be designed to contain the peak runoff from the frequency storm shown in Table 2.1, which includes the design to have sufficient freeboard to provide for adequate drainage of lateral storm sewers. Properties over which the surface waters are conveyed, from the development site to discharge point, shall not be adversely affected.

In those cases where channel modifications are necessary to control increased flow from proposed development, proposed water surface profiles are restricted such that the 100-year flood profile under existing conditions shall not be increased. If the capacity of the existing channel downstream of the project is less than the 100-year design discharge, consideration shall be given for more frequent events to ensure that the severity and frequency of downstream flooding is not increased.

5.2.2. CHANNEL GEOMETRY, SLOPE & VELOCITY

A. CHANNEL SIDE SLOPE

In grass-lined channels, the normal maximum side slope shall be no steeper than 3 horizontal to 1 vertical (3:1), which is the practical limit for mowing equipment. In some areas, local soil conditions may dictate the use of side slopes flatter than 3:1 to ensure slope stability.

B. CHANNEL BOTTOM WIDTH

In grass-lined channels, the minimum channel bottom width shall be 2 feet. In concrete-lined channels, the minimum bottom width shall be 2 feet except where concrete lined “V” shaped roadside ditches are used.

C. CHANNEL FLOW-LINE SLOPE

Slope of the channel flow-line (invert) is generally governed by topography and the energy head required for flow. Since flow-line slope directly affects channel velocities, channels should have sufficient grade to prevent significant siltation. However, slopes should not be so large as to create erosion problems. In the Town of Clayton, unless approved by the Engineering Director, the minimum recommended longitudinal slope shall be 0.4 percent (0.004). The use of flatter slopes must be approved by the Engineering Director. The maximum channel invert slope will be limited by the maximum flow velocities given in Table 5.1. Appropriate channel drop structures may be used to limit channel invert slopes in steep areas.

D. CHANNEL FLOW VELOCITIES

Excessive flow velocities in open channels can cause erosion and destabilize side slopes and may pose a threat to safety. Velocities, which are too low, may allow the deposition of sediment and subsequent channel clogging. Table 5.1 provides desirable average and maximum permissible design velocities based on 10-year storm peak runoff rates for newly vegetated or armor-lined channels.

Table 5.1
Flow Design Velocities for Newly Vegetated and Armored Channels

Channel Description	Average Velocity (Feet Per Second)	Maximum Velocity (Feet Per Second)
Grass Lined: Predominantly Clayey Soils	3.0	4.0
Grass Lined: Predominantly Sandy Soils	2.0	4.0
Rip-Rap Lined	5.0	8.0
Concrete Lined	6.0	10.0

5.2.3. CHANNEL PROTECTION

A. DRAINAGE WAYS

The development shall adequately protect all ditches and drainage ways to the satisfaction of the Town. Ditches and open channels shall be stabilized, seeded, and mulched, turf reinforced, sodded or armored, depending on grades and types of soils. As a general rule, ditches and channels, when permitted, shall be lined a follows:

Table 5.2
Minimum Ditch Liners Requirements[a]

Grade	Liner
grades up to 1 percent	Seeded, mulched and tacked
grades of 1 to 4 percent	Turf Reinforcement/ Sod
grades over 4 percent	Armored

[a]All liners selected are to be designed in accordance with the requirements of the Erosion and Sediment Control Planning and Design Manual

Seeding, sodding, and armoring operations shall be in compliance with the NCDOT *Standard specifications for Roads and Structures*, latest edition. It is not sufficient to have planted according to these specifications. There must be a good stand of permanent grass to meet this requirement. Calculation shall be made to determine the need for riprap outlet protection at pipe outlets.

B. **EASEMENTS**

The watercourse or ditch easement shall be wide enough to contain said ditch with ample clearance for the operation of maintenance equipment. The minimum easement width shall be 20 feet. See Table 1.2.

C. **DOWNSTREAM PROTECTION**

Stream banks and channels downstream from the development shall be protected from increased degradation by accelerated erosion caused by increased velocity of runoff from the construction activity. Supporting calculations may be required at the discretion of the Town Stormwater Program Manager.

The construction activity shall be planned and conducted in such a manner that the velocity of storm water runoff in the receiving watercourse at the point of discharge resulting from the 10-year storm after development shall not exceed the greater of:

1. The velocity as determined from the velocity in the *NC Erosion and Sediment Control Planning and Design Manual*, or

2. The velocity in the receiving watercourse determined for the 10-year storm prior to development.

   If neither 1 nor 2 can be met, the channel below the discharge point shall be designed and constructed to withstand the expected velocity.

   Measures applied alone or in combination to satisfy the intent of this paragraph are acceptable if there are no objectionable secondary consequences. Innovative techniques and ideas will be considered and may be used when shown to have the potential to produce successful results. Some alternatives are to:

a. Avoid increases in surface runoff volume and velocity by including measures to promote infiltration to compensate for increased runoff from areas rendered impervious.

b. Provide energy dissipaters at outlets of storm drainage facilities to reduce flow velocity at the point of discharge from the development; these may range from simple riprap sections to complex structures.

c. Protect watercourses subject to accelerated erosion by improving cross-sections and/or providing erosion resistant lining.

D. UPSTREAM PROTECTION

1. Maximum allowable high water levels should be established along the storm drainage system prior to initiating hydraulic evaluations.

2. The headwater elevation of existing streams or pipe culverts upstream of the proposed development shall not be increased above the pre-development elevations from either the design storms shown in Table 2.1 or from a 100-year 24-hour storm event, whichever is greater.

3. Small drainage basins upstream of the proposed development shall be given consideration for the potential of flooding due to short duration high intensity storm events.

4. When applicable, evaluation of an upstream drainage basin shall be given consideration for the potential of grate clogging (i.e. yard and roadway grated inlets). Assume a clogging factor of 50% for single grates in a sump condition.

5. Any evaluation of the upstream drainage basin shall consider the potential impact of flooding existing upstream basements or near grade finished floors (slab-on-grade or crawl space) and make allowances to prevent the new development from increasing the pre-existing high water elevation.

E. CHANNEL EROSION CONTROL

Erosion protection is necessary to ensure that channels maintain their capacity and stability and to avoid excessive transport and deposition of eroded material. All Erosion and Sediment Control Plans measures shall be designed in accordance with the *NC Erosion and Sediment Control Planning and Design Manual*, latest revision.

Erosion and Sedimentation Control Plans, permit applications, and fees shall be submitted in to the Town of Clayton

Section 6 – STORMWATER MANAGEMENT DESIGN

The purpose of this section is to provide a guide for the design of stormwater management concerning Phase II Stormwater and Neuse River Nutrient Management regulations.

6.1 INTRODUCTION & OBJECTIVE

The Phase II stormwater permitting programs were established under the Federal Clean Water Act of 1972. The delegation of that program was accepted by the NC Division of Water Resources (DWQ), a section of NC Department of Environmental Quality (NCDEQ). Based on the requirements from the Clean Water Act, the following are goals that required under the Phase II program:

- Public education and outreach on stormwater impacts,
- Public involvement and participation,
- Illicit discharge detection and elimination,
- Construction site stormwater runoff control,
- Post-construction stormwater management for new development and redevelopment, and
- Pollution prevention/good housekeeping for municipal operation.

This manual is being implemented to provide guidance and design methodology for the post-construction stormwater management for new development and redevelopment within the Town of Clayton limits and ETJ. This manual is intended to provide technical information in support of Section 6.15 of the Town of Clayton UDO, and possible strategies to meet the requirements set by the Ordinance.

The Town of Clayton is required to comply with NPDES Phase II regulations and Neuse River Nutrient Management Strategy for stormwater runoff and this manual provides the information needed to design and treat stormwater runoff in accordance with both regulations.

Designer to refer to the NCDEQ Division of Energy, Mineral, and Land Resources *Stormwater Design Manual*, and this Manual. Note that in any discrepancy between the NCDEQ Stormwater Design Manual and the Town of Clayton Manual of Specifications, Standards and Design, or other regulations or ordinances, the more stringent of the requirements apply.

6.1.1 Applicability and Exemptions:

Per the Stormwater Management Ordinance, requirements of this section shall apply to all development and redevelopment, including but not limited to: Site Plan Approval, Subdivision Approval, and grading approval, unless exempt pursuant to this section within the Town of Clayton Planning Jurisdiction. Refer to Definitions within Section 8.3 *Terms Defined* of the Town of Clayton UDO.

A. Exemptions:

1. Single-family detached, duplex, and manufactured home dwellings and recreational development and redevelopment that cumulatively disturbs **less than one (1) acre** and are not part of a larger common plan of development or sale are exempt from the provisions of this chapter, unless deemed otherwise by the Stormwater Administrator.

2. Commercial, industrial, institutional, single-family attached and multi-family residential, or local government development and redevelopment that cumulatively disturbs **less than one-half (0.5) acre** and are not part of a larger common plan of development or sale are exempt from the provisions of this chapter.

3. Development and redevelopment that disturb less than a stated area threshold are not exempt if such activities are part of a larger common plan of development or sale that exceeds the relevant threshold, even though multiple, separate or distinct activities take place at different times on different schedules.

4. Activities that are exempt from permit requirements of Section 404 of the federal Clean Water Act as specified in 40 CFR 232 (primarily, ongoing farming and forestry activities) are exempt from the provisions of this chapter.

5. Per the requirements of 15A NCAC 02B .0711 and the Town's Phase II Permit NCS000559, new development undertaken by a local government solely as a public road project shall be deemed compliant with the purposed of this chapter if it meets the riparian buffer protection requirements of The Neuse River Buffer Rules.

   For these public road projects, the following shall be done to the maximum extent practicable (MEP):
   - Minimize BUA;
   - Divert runoff away from surface waters; and
   - Implement BMPS and SCMs.

6. Existing impervious surfaces established prior to November 1, 2008, as determined through aerial photography, permits, plans, etc. however, if the impervious area limits are reduced after November 1, 2008 and the previously impervious area is reestablished as pervious for a period of one year or more, the impervious area is no longer exempt.

7. See also the exclusions listed under Section 6.14.*2B Exclusions From Regulate Land-Disturbing Activity* of the Town of Clayton UDO.

6.1.2 Stormwater Standards

A. General Standards:

All development and redevelopment to which this chapter applies shall comply with the standards of this subchapter. The approval of the Stormwater Permit shall require

enforceable restriction on property usage that runs with the land, such as a recorded deed restriction or protective covenants, to ensure that future development and redevelopment maintains the site consistent with the approved project plans.

B. Neuse River Estuary Nutrient Management Requirements:

Nitrogen loads contributed by the proposed development shall not exceed **3.6 pounds per acre per year** as documented by the latest NCDEQ-approved nutrient accounting tool, (i.e., the NCDEQ SNAP Tool). Refer to **Section 6.3.**

C. All stormwater control measures used to meet these requirements shall be designed to have a minimum of eighty-five (85%) percent average annual removal for Total Suspended Solids (TSS). Refer to Section 7.2.1**.**

D. Control and Treatment of Runoff Volume:

1. Stormwater systems shall be designed to control and treat runoff volume generated from all surfaces by **one (1) inch of rainfall:** the treatment volume. The treatment volume shall not exceed the maximum ponding depth and be drawn down pursuant to standards specific to each practice as provided in the Design Manual.

2. To minimize flooding and to ensure that the integrity and nutrient processing functions of receiving waters and associated riparian buffers are not compromised by evasive flows, stormwater flows from development or redevelopment shall not contribute to degradation of waters of the State.

   At a minimum, the development and redevelopment shall not result in a net increase in peak flow leaving the site from pre-development conditions for the **1-year, 24-hour storm**; **2-year, 24-hour storm**; and **10-year, 24-hour storm events;** and **25-year 24-hour storm events.**

6.2 GENERAL PROCEDURES

Per the Stormwater Management Ordinance/UDO, a Stormwater Permit is required for all development and redevelopment within the Town of Clayton limits and ETJ. The Permit must be applied by the developer or owner of the site where the development is proposed. The developer or owner must sign the Permit Application and provide the required development information as listed below in Section 6.2.1.

Prior to submitting the Stormwater Permit, it is recommended that the owner/developer and his/her consultant schedule a meeting for a Pre-Design Conference with the Stormwater Administrator. This Conference may help with the overall understanding and expectations for the site development and the requirements that will need to be met for the Town of Clayton. The discussions will be centered on the information needed per this design manual and will cover other site-specific concerns or questions that could arise during the design of the site.

All plans and calculations shall be prepared by a qualified registered North Carolina professional engineer, surveyor, soil scientist or landscape architect, and the engineer, surveyor, soil scientist or landscape architect shall perform services only in their area of

competence, and shall verify under seal that the design of all stormwater management facilities and practices meets the submittal requirements for complete applications, that the designs and plans are sufficient to comply with applicable standards and policies found in the Design Manual, and that the designs and plans ensure compliance with the Stormwater Management Ordinance.

6.2.1 Stormwater Permit Application

The Stormwater Permit Application package should be inclusive of all necessary materials to understand the design and how the site will be developed in relation to stormwater management. At a minimum, the application must be submitted with the items as detailed in the Stormwater Permit Application Checklist, including:

- Stormwater Permit Application
- Stormwater Permit Application Checklist
- Stormwater Management Plans and Details, including Landscaping Plan if applicable
- Stormwater Management Statement/ Calculations/ Runoff Maps
- NCDEQ SNAP Tool, latest version (in PDF and .xslx)
- NCDEQ Supplement EZ Forms for each SCM, if applicable
- Documentation of approval from NCDEQ/COE, if required.

Preliminary subdivision plats that do not include all completed items WILL NOT be considered complete and may not be included on the Planning Board agenda.

6.2.2 Stormwater Management Statement/Narrative

A Stormwater Management statement or narrative is required with all plans submissions to help the Stormwater Administrator determine how the stormwater management facility was designed. The statement must be sent in with the preliminary subdivision plat for either commercial or residential subdivisions. The statement will be approved and reviewed by the Town of Clayton Engineering Director or Stormwater Administrator. If the design has not changed between the preliminary and the construction plat, then resubmission of the Stormwater Management Statement will not be necessary. If substantial changes were made to the stormwater management for the site, a modified Stormwater Management Statement must be submitted for review and approval by the Town of Clayton.

At a minimum, the Stormwater Management Statement must include:

1. Development name and address.
2. Developer/Owner and Consultant contact information.
3. A description of the existing site.
4. A description of the proposed development or construction activity.
5. An impervious area calculation for both existing site and proposed site conditions.
6. A description of the stormwater impacts the proposed development or construction activity may have on the surrounding properties. This includes

identifying upstream and downstream drainage facilities potentially affected by the new development and the ability of the existing drainage ways to handle the additional runoff.

7. A description of the proposed stormwater management facility and how they will be designed, constructed, maintained and operated to:
   a. Minimize the adverse effects on the quality of stormwater runoff from the development,
   b. Provide SCM's to maximize infiltration, minimize connected impervious surfaces and minimize concentrated flows,
   c. Provide distributed stormwater runoff to minimize offsite impacts and provide sheet flow into existing vegetated buffers,
   d. Extend the time of concentration to the maximum practical level.
   e. Preserve and protect the natural drainage ways,
   f. Respect the practical limits of public and private drainage facilities,
   g. Protect neighboring properties from unreasonable adverse effects resulting from the development,
   h. Prevent flooding within the development and on surrounding properties, and
   i. Limit the impacts of stormwater runoff discharging into or from the site or obtain approvals and easements from the affected property owners.
8. Estimated cost for construction and continued maintenance of the SCM(s).
9. A vicinity map showing the location of the site within the Town limits. The scale of the map shall be adequate to show the area in question with reasonable depiction of streets to determine the exact location of the site. The minimum scale shall be no less than 1"=400'.
10. A USGS Quadrangle map with the site location depicted on the map.
11. A copy of the Johnston County Soil Survey with the site location depicted on the map. The map must be from the official publication. The website version can be used for soil breakouts and design but cannot be used for stream determination.
12. Additional supporting documentation as included on the Stormwater Permit Checklist.

6.3 NEUSE RIVER NUTRIENT MANAGEMENT REQUIREMENTS

On June 22, 1999, The Environmental Management Commission adopted the Neuse River Basin: Nutrient Sensitive Waters Management Strategy: Protection and Maintenance of Riparian Buffers (15A NCAC 2B .0233). The purpose of the rule is to protect and preserve the riparian buffers in the Neuse River Basin to maintain their nutrient removal functions. The Town of Clayton requires all site plans and subdivisions submitted for Town review to have all streams identified and riparian buffers noted on the maps where applicable.

The Neuse River Riparian Buffer rules apply to all existing streams, lakes, ponds or other bodies of water if the feature is shown on either the most recent version of a 1:24,000 scale (7.5 minute) quadrangle topographic map prepared by the USGS or the most recent version of the soil survey map prepared by the NRCS. The Neuse River Riparian Buffer rules implement and pertain to a 50' Riparian Buffer around all water features as noted above. Exemptions from the Neuse River Basin Rules for riparian buffers along surface waters that appear on the maps must be obtained in writing from the NCDEQ Division of Water Resources.

Approval from the Division of Water Resources (DWR) will be required prior to the Town of Clayton Stormwater Permit approval for any sites that appear to be impacting riparian buffers. For more information on allowable activities within a riparian buffer or along a stream or for detailed information for exemptions from the riparian buffer rule, contact the NCDEQ DWR Raleigh Regional Office at (919) 791-4200, or at https://www.deq.nc.gov/about/divisions/water-resources/water-planning/nonpoint-source-planning/neuse-nutrient-strategy#RiparianBuffers-2777

All proposed development and construction activity located near or adjacent to a riparian buffer must adhere to the Neuse River Basin Rules. In particular, the following items must be addressed, where applicable, on all Stormwater Management Plans:

1. All surface waters, as shown on the USGS Quadrangles or Johnston County Soil Survey, must be shown on the proposed plan.
2. All riparian buffers must be appropriately labeled on the proposed plan and final plat. Riparian buffers must extend 50 feet from the top of bank for streams or the edge of normal water levels for ponds and other impoundments.
3. Where development requires the disturbance of a riparian buffer, documentation of approval from NCDEQ DWR is required. If the project is considered exempt, documentation or an explanation should be provided noting this, utilizing the conditions stated in the Neuse River Basin Rules.
4. Diffuse flow must be provided for all stormwater runoff entering the riparian buffer. The following guidelines should be utilized:
    a. Development located near riparian buffers should minimize large concentrated discharge points. By providing multiple outlets for stormwater runoff and maintaining natural drainage patterns, the stormwater runoff impacts from new development can be minimized.
    b. Documentation must be provided, indicating that the proposed development has provided sheet flow at all discharge points where required. Appropriate calculations and details should be included.
    c. Additional methods to provide diffuse flow will be reviewed and approved on an individual basis. Developers and design professionals may request a pre-design conference to determine if a proposed facility will be accepted.
    d. The NCDEQ *Division of Energy, Mineral and Land Resources*, Level Spreader Design Guidelines, latest revision, can be utilized except sod shall be utilized.

e. Discharge that will flow into an existing, non-buffered draw or stream, prior to entering the riparian buffer will be exempt from the diffuse flow requirement.

5. All stormwater facilities proposed to create sheet flow must be contained within permanent drainage easements and have Operation and Maintenance Agreement and/or guidelines provided in the restrictive covenants. The Operation and Maintenance Agreements and the restrictive covenants must be recorded.

6.3.1. Nitrogen Reduction

The Neuse River Basin – Nutrient Sensitive Waters Management Strategy: *Basin Wide Stormwater Requirements* (15A NCAC 2B .0235) and the Town of Clayton Stormwater Management Ordinance requires development to reduce nitrogen loading by installing SCMs, both structural and non-structural, or by offsetting payments to NC Division of Mitigation Services (DMS) or a local nutrient mitigation bank.

Designer to refer to the NCDEQ Division of Energy, Mining and Land Resources *Stormwater Design Manual*, and this Manual. Note that in any discrepancy between the NCDEQ Stormwater Design Manual and the Town of Clayton Manual of Specifications, Standards and Design, or other regulations or ordinances, the more stringent of the requirements apply.

6.3.2. Total Nitrogen Loading Calculations

A. Nitrogen loads contributed by the proposed development shall not exceed **3.6 pounds per acre per year**.

B. Redevelopment subject to this chapter that would replace or expand existing structures or improvements and would result in a net increase in built-upon area shall have the option of either meeting the loading standards identified in subsection or meeting a loading rate that achieves the following nutrient loads compared to the existing development: thirty-five (35) percent reduction for nitrogen.

C. The developer shall determine the need for engineered stormwater controls to meet these loading rate targets by using the latest NCDEQ-approved nutrient accounting tool, i.e., the NCDEQ SNAP Tool.

6.3.3. Nitrogen Export Reduction Options

NCDEQ DWQ requires that the total nitrogen loading be less than **3.6 lbs/ac/yr** for any development in the Town of Clayton jurisdiction. There are three options to reduce this export as listed:

A. SCMs as described in Section 7 can be installed to reduce the nitrogen loading rate from the development. The rate or removal is dependent on the type of SCM utilized as noted in the NCDEQ Stormwater Design Manual.

B. A onetime payment (offset payment) can be paid to NC DMS or a local nutrient mitigation bank, or

C. A combination of SCMs and offset payment.

6.3.4. Partial Offset of Nutrient Control Requirements

A. Development shall attain a maximum nitrogen loading rate on-site of six pounds per acre **(6 lbs/ac/yr)** per year for single-family detached and duplex residential development, and ten pounds per acre per year **(10 lbs/ac/yr)** for other development, including multi-family residential, commercial, and industrial, and shall meet any requirements for engineered stormwater controls otherwise imposed by this article.

B. A developer subject to this article may achieve the additional reductions in nitrogen and phosphorus loading required by this article by use of the following options:

   i. Purchasing offset credits from an approved private seller with a project located in the same eight-digit Hydrologic Unit Code (8-digit HUC) as the proposed development. Refer to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS) for approved mitigation banks with applicable and eligible credits in Clayton.

   ii. Making offset payments to the NC Division of Mitigation Services (DMS) contingent upon acceptance of payments by that program.

C. Documentation and proof of purchase for offset credit options is required prior to construction plan approval.

D. Any offsite measures permitted by the Ordinance shall meet the requirements of 15A NCAC 02B .0273 (2) through (4) and 15A NCAC 02B. 0240.

6.4 IMPERVIOUS AREA CALCULATIONS

All Stormwater Management Permit applications must include calculations documenting the total proposed impervious area within the development. Impervious areas are defined as all surfaces composed of material that impedes or prevents natural infiltration of water into the soil. Examples of impervious surfaces include pavement, concrete, gravel and roofed surfaces.

For single-family residential subdivisions, where the exact building footprint per lot is unknown, a maximum impervious surface area for the site for each lot can be utilized to determine compliance with the maximum impervious area allowed within the development. The following criteria should be adhered to when using this option:

A. A reasonable impervious area per lot must be used in the calculations. Documentation that the area used will be adequate for the intended use is required. A typical plot plan or analyses of existing impervious area in surrounding, comparable developments can be provided to meet this requirement.

B. The Town prefers residential developments to utilize a maximum impervious area per lot as opposed to an average area per lot. If the development must utilize an average impervious area, reasonable explanation must be provided. If an average impervious area is used, the developer must track the development internally and provide annual (or as requested) updates to the Town.

C. The Town reserves the right to request as-built documentation from the developer, verifying that the proposed maximum impervious areas have not been exceeded.

D. The Town encourages additional impervious area per lot be provided for future expansion by the homeowner (e.g., 100-500 sf per lot for sheds, screened porches or additions).

E. All impervious area within the proposed right-of-way, but outside of the edge of roadway pavement must be included in the allowable impervious area per lot.

F. The maximum impervious area allowed per lot (or average) must be recorded on the Final Plat and noted in the restrictive covenants recorded for the subdivision. The following note can be followed as an example to meet this requirement:

- Impervious area includes all buildings, sheds, sidewalks, covered porches, driveways, and surfaces such as gravel, concrete, asphalt, brick, slate or stone that impeded the infiltration of water into the soil. The maximum impervious area allowed per lot should include any impervious area proposed within the portion of the right-of-way between the edge of roadway pavement and the front of the lot line.

If a development area includes existing impervious areas, all impervious areas to remain must be included in the total impervious area calculations. Existing impervious areas that are removed are not required to be included in the maximum allowable impervious area limits. However, any existing impervious area that existed prior to adoption of either the Watershed Protection Regulations or the Neuse River Watershed Regulations is grandfathered.

Section 7 – STORMWATER CONTROL MEASURES

7.1 INTRODUCTION

Management of nonpoint source discharge is a stated goal of the 1987 Water Quality Act. An important source of these pollutants is stormwater runoff from urban and developing areas. This runoff has the potential to degrade water quality in all types of waters, including, among others, those classified as water supply watersheds, shellfish areas, and nutrient sensitive waters. The management of stormwater runoff through nonstructural controls (e.g., low-density development) is the preferred method of reducing pollution from urban areas. In cases where low density is not feasible, engineered stormwater controls are viable solution to reducing pollution. However, proper design, and subsequent management, of these engineered solutions is essential for adequate pollutant removal.

DWQ's approach to water quality management of stormwater in surface drinking water supply watersheds, the 20 coastal counties, and areas near High Quality and Outstanding Resource Waters is based first on minimizing impervious surfaces and; secondly, on treating stormwater runoff from these surfaces. The rules contained in 15A NCAC 2H .1000 for wet detention basins provide information on the appropriate volume of runoff to be controlled and the corresponding basin size configuration. North Carolina Stormwater Management rules also allow for the construction of alternative SCM's that meet the pollutant removal design standard of 85% removal of total suspended solids (TSS). This section, along with the standard details, is meant to supplement the rules in the NCAC by providing design checklists and details, their design criteria, and their assumed TSS removal. These guidelines are not meant to replace the rules.

Designer to refer to the NCDEQ Division of Energy, Mineral, and Land Resources *Stormwater Design Manual*, and this Manual. Note that in any discrepancy between the NCDEQ Stormwater Design Manual and the Town of Clayton Manual of Specifications, Standards and Design, or other regulations or ordinances, the more stringent of the requirements apply.

7.2 SUPPLEMENTAL TOWN REQUIREMENTS FOR SCMs

The NC Department of Environmental Quality (NCDEQ), Division of Energy, Minerals, and Land Resources has published a Stormwater Design Manual, that is updated continuously. The Town of Clayton has adapted the information and minimum design criteria in this publication for guidance in designing water quality SCM's.

7.2.1. Total Suspended Solids (TSS) Removal

As described in section 6.15.8 of the Town of Clayton UDO, nitrogen loading standards in this article are supplemental to, not replacements for, stormwater standards otherwise required by federal, state, or local law, including without limitation any riparian buffer requirements applicable to the location of the development. This includes, without limitation, the riparian buffer protection requirements of 15A NCAC 2B.0714.

All stormwater control measures used to meet these requirements shall be designed to have a minimum of eighty-five (85%) percent average annual removal for TSS.

7.2.2. Freeboard

A minimum of one (1) foot of freeboard shall be provided for above ground SCM's for the 100-year, 24-hour storm event.

A minimum of six (6) inches of freeboard shall be provided for underground SCM's for the 100-year, 24-hour storm event.

7.2.3. Fencing

Fencing shall be installed around above ground SCMs unless otherwise approved by the Stormwater Administrator on a case by case basis. Fencing shall be constructed of high-quality materials, such as decorative blocks, brick, stone, treated wood, wrought iron, black vinyl coated chain link fence, or vinyl or treated wood privacy fence and details/shop drawings approved by the Stormwater Administrator prior to plan approval.

Fencing shall be owned/maintained by the owner/HOA and shall be installed prior to final SCM certification. See also paragraph 7.2.5, below.

7.2.4. SCMs Not to be on Single-Family Lots

SCMs shall not be located on private single-family lots if serving other lots. Refer to easement requirements in Section 1.9.3.

7.2.5. Final Plat Notes

The following notes shall be placed on all Final Plats that require drainage easements or SCMs:

A. "The drainage easements and stormwater control measures shown hereon are required on the property to meet Town and state stormwater regulations. Property Owner may be subject to enforcement actions if the maintenance easement is obstructed or stormwater control measure is removed, relocated or altered without prior Town approval."

B. "No structures, fences, walls, HVAC equipment, trees, shrubs, hardscapes or other items that obstruct maintenance vehicles may be installed within drainage easements. Per the Operation and Maintenance Agreement recorded in the Register of Deeds, the property owners grant the Town the right, privilege and easement across the property for the purpose of inspecting, monitoring, etc., the stormwater control measure as needed. Note that maintenance of the drainage easement is the responsibility of the underlying property owner, who shall maintain the easement to allow positive conveyance of stormwater."

C. "The maximum impervious area allowed per lot (or average) is _____ sf. Impervious area includes all buildings, sheds, sidewalks, covered porches, driveways, and surfaces such as gravel, concrete, asphalt, brick, slate or stone that impeded the infiltration of water into the soil. The maximum impervious area allowed per lot should include any impervious area proposed within the portion of the right-of-way between the edge of roadway pavement and the front of the lot line." (Refer to Section 6.4).

7.3 DETAILS

The **Standard Details:** Refer to NCDEQ Division of Energy, Mineral, and Land Resources *Stormwater Design Manual*. Note that in any discrepancy between the NCDEQ and Town of Clayton requirements, the more stringent of the requirements apply.

Section 8 - INSPECTION & ACCEPTANCE

8.1 LIMITS OF PUBLIC OWNERSHIP AND MAINTENANCE RESPONSIBILITY:

A. All drainage easements carrying water from the right of way or public property shall be public and maintained by the Town of Clayton.

B. The Town of Clayton assumes no liability or responsibility for adjudicating disputes between property owners regarding non-publicly generated storm water.

C. Drainage systems maintained by NCDOT as part of its State highway system.

D. **Detention/Retention/Water Quality Pond & Other SCM's**: The Town will not accept these areas/structures for maintenance; however, the Town reserves the right to enter to routinely inspect these areas and address any items that would cause SCM(s) to be noncompliant. This will be done in an emergency situation without notice. Under normal conditions, the Town will contact the owner/developer to have said items addressed. If unable to do so within a reasonable time, the Town reserves the right to charge the owner/developer for any expense incurred by the Town in doing so.

8.2 LIMITATION OF CONSEQUENTIAL DAMAGE TO PRIVATE FACILITIES LOCATED ON PUBLIC EASEMENTS

All public easements including storm sewer are to remain clear of obstructions. No buildings, fences, trees, shrubs or other obstructions shall be placed in any easement. Driveways, walkways, asphalt and parking lots may be permitted in easements; however, the Town reserves the right to remove such asphalt, concrete, base course and sod as necessary to access its facility in the case of emergency. Pavement or concrete will be replaced with a **patch**. Sod will be replaced with Fescue or rye seeding. The Town will **not** be responsible for replacing a property owner's sod after repairing a drainage line.

8.3 ITEMS NEEDED FOR ACCEPTANCE

A. Record drawings need to be submitted after final inspection and prior to acceptance.

B. Bond will be required to be submitted. Bond amount of 20% of the construction cost but no less than $3,000.

C. All public stormwater structures shall be surveyed and tied into the NC State grid for upload into GIS. A record drawing shall be submitted to the Town of Clayton for approval with the record drawing certificate on the plan. Once approval of the record drawings are obtained, a hard copy with a CAD drawing (formattable to GIS) must be submitted to the Engineering Director or Stormwater Program Administrator.

8.4 INSPECTIONS:

8.4.1 The following items must be inspected during and after installation of storm drainage lines and appurtenances:

A. All boxes and manholes for presence of weep holes, formed inverts, castings, pipe flushed against inside wall of box, steps and location of steps, proper corbelling of brick/block in accordance with the details and specs, wall thickness and depth of manhole.

B. Pipe for cracks.

C. Removal of debris and sediment in both pipe and box.

D. Rip rap outlet protection and filter fabric, stilling basin compliance with plan if applicable.

E. Armor protection of ditches (concrete and/or temporary liners), scour, and erosion.

8.4.2 All inspections must be scheduled at least 24 hours prior to when needed. Inspections will be performed in the order received. Every effort will be made to accommodate the time of request; however, this cannot be guaranteed.

8.4.3 Upon completion of construction the developer shall request a warranty inspection. Upon completion of all punch list items, the provision of a set of acceptable record (as-built) drawings, and the submission of engineer's certifications, a 1-year warranty period shall commence.

8.4.4 Per UDO Section 6.15.9, a completed Annual SCM Certification form shall be provided to the Stormwater Administrator beginning one year from the date of as-built certification and each year thereafter on or before the date of the as-built certification.

8.5 WARRANTY:

If a developer fails to complete warranty items, future projects of the developer shall not be reviewed by the Department of Public Works and Utilities. In addition, the Town may take additional legal action against the developer.

8.5.1 New development draining to an existing regional pond:

A. In order to ensure compliance of all post construction stormwater structures installed as either part of the Neuse Nitrogen Stormwater Program or Watershed Supply Protection Regulations, the Town has adopted a policy to not allow any `new construction which drains to a regional pond to either receive a final plat or a Certificate of Occupancy if the receiving regional pond is out of compliance at the time the new construction is complete.

B. The Town will not accept any new development which drains to an existing regional pond unless the regional pond is in compliance with current Town of Clayton Stormwater regulations.

C. ***Regional SCM's must be inspected by the Town and in compliance prior to signing of a final plat of issuance of a Certificate of Occupancy.***

D. Developers are encouraged to contact the Town's Stormwater Administrator to perform a site inspection well in advance of the desired time of Certificate of Occupancy (C.O.) or final plat. Failure to do so may lead to delays in C.O. or final plat issuance due to non-compliant Best Management Practices.

8.5.2 **Warranty and Defects Guarantee**: Upon the acceptance of facilities, utilities or streets for permanent maintenance, a 1-year warranty for all improvements shall become effective. This warranty must be satisfactory to the Town of Clayton. In addition, the subdivider shall provide surety in the amount of 15% of the total construction cost to guarantee the correction of all defects in such facilities, utilities, or streets that occur within the warranty period described above.

For the purposes of this section, the term "defects" refers to any condition in publicly dedicated facilities, utilities or streets that requires the Town to make repairs to such improvements over and above the normal amount of maintenance that they would require. If such defects appear, the warranty may be enforced regardless of whether the facilities, utilities, or streets were constructed in accordance with the requirements of this ordinance.

8.5.3 During the 1-year warranty period, the developer shall repair any latent defects which occur. At the end of the 1-year warranty period the developer shall request a final inspection. Upon successful completion of all warranty items the developer shall be released from maintenance responsibilities for the warranted construction.

8.5.4 Warranty repairs to the following common problems shall be as follows:

A. Street pavement trench failures shall be repaired in accordance with the Town Manual of Specifications, Standards, and Design as well as at the direction of the Engineering Director.

B. If more than 3 trench failures occur within a longitudinal distance of 800 feet on any segment of a street, the Town may require a 1-inch overlay once repairs have been completed.

C. Cracks in sidewalk and/or curb and gutter shall be repaired by removing and re-pouring such sections as necessary.

D. All storm sewer systems, ditches and gutters shall be free of debris, dirt or silt;

E. All drainage and street appurtenances shall be in perfect condition and properly exposed.

All other defects shall be corrected in accordance with the recommendations of the Town's Engineer or his representative.

8.6 Annual Inspections

Even though the Town of Clayton will not maintain Stormwater Control Measures (SCMs), the Sections 8.4 and 8.6 above apply and will be required prior to the final CO or Final

Plat. A warranty inspection will not be required; however, a yearly maintenance inspection and certification by a registered professional. Per Section 6.15.9 of the UDO, a completed Annual SCM Certification Form shall be provided to the Stormwater Administrator beginning one year from the date of as-built certification and each year thereafter on or before the date of the as-built certification.

Section 9 – FINANCIAL

9.1 NEW SUBDIVISION AND NEW CONSTRUCTION EXCLUDED

Construction of storm drainage in any new development shall be the sole responsibility of the developer at his/her expense and shall be installed in accordance with the Manual of Specifications, Standards, and Design.

9.2 PRIVATE PROPERTY – OTHER THAN NEW SUBDIVISIONS:

9.2.1 The Town will issue permits for the installation of storm drains crossing private property other than in new subdivisions within the Town's corporate limits under the following conditions:

A. The storm drain to be installed will carry storm drainage water discharged from an existing Town street ("Public" Water) or streets dedicated for public street purpose and accepted for maintenance by the Town.

B. The property owner(s) will furnish the Town, without cost, a duly executed good and sufficient easement, conveying to the Town such perpetual right-of-way determined by the Engineering Director as necessary for the installation and maintenance of the storm drain, the form and sufficiency of such easement to be determined by the Town Attorney (easement is defined as a right, as a right of way, afforded to the Town of Clayton for limited use of another's real property). The Town will not be responsible for any shrubs, trees or structures within the right-of-way and permanent structures may not be built by owner(s) over the right-of-way.

C. At the time of the property owner's application to the Town, the storm drain system to be installed is to be located on property on which a residential, commercial, or industrial building has existed for a period of 60 months and the desirability or necessity for such installation is not due to a planned expansion or modification of such existing building nor to an expansion or modification made to such existing building within a 60 month period prior to the date of such application.

D. The pipe, size, alignment, grade, length, discharge point, structural accessories (such as manholes, headwalls, catch basins, junction boxes), and other specifications shall be as determined by the Engineering Director.

E. The installation of proposed drainage structure shall be in compliance with the Division of Energy, Mineral, and Land Resources Stormwater Design Manual and the corresponding standard details and specification of the MSSD.

9.2.2 It shall be the policy of the Town to improve sections of open ditch in sufficient length as determined by the Engineering Director.

9.2.3 Notwithstanding, all ditch improvements are subject to the applicable regulations governing wetlands, waters of the US, buffers, etc. as promulgated by the US Army Corps of Engineers and NCDEQ, Division of Water Resources; such regulations taking

precedent over any permitted practice or policy stated herein. As such, requests for rerouting or piping existing ditches or streams shall be subject to all federal, state, and local regulations which may prohibit the disturbance of applicable ditches, wetlands, streams, etc.

9.2.4 Storm drainage crossing private property which does not carry storm drainage from an existing Town street or streets dedicated for public street purposes and accepted by the Town for maintenance is the responsibility of the property owner(s) and the Town, therefore, will not participate in the installation.

Section 10 – EXAMPLE PROBLEMS

10.1 CALCULATING RUNOFF – RATIONAL METHOD

10.1.1 Rational Method

The Rational Method represents an accepted method for determining peak storm runoff rates for small watersheds that have a drainage system unaffected by complex hydrologic situations such as ponding areas and storage basins. It is generally recommended that in the Town of Clayton that Rational Method be used for areas of less than 50 acres.

The Rational Method is based on a direct relationship between rainfall intensity and runoff, and is expressed by the following equation:

$$Q = CiA$$ Equation 10.1.1

Where, Q → The peak rate of runoff in cubic feet per second (cfs). Actually, *Q* is in units of inches per hour per acre. Since this rate of inches-acre/hour differs from cubic feet per second by less than one percent, the more convenient units of cfs are used.

C → The dimensionless coefficient of runoff representing the ratio of peak discharge per acre to rainfall intensity (i).

i → The average intensity of rainfall in inches per hour for a period of time equal to the time of concentration for the drainage area at the point of interest.

A → The area in acres contributing runoff to the point of interest during the critical storm duration.

Basic assumptions associated with the Rational Method are:

1) The frequency or recurrence interval of the peak discharge is equal to the frequency of the average (uniform) rainfall intensity associated with the critical storm duration.
2) The computed peak rate of runoff at the point of interest is a function of the average rainfall intensity during a period of time equal to the time of concentration at that point.
3) The time of concentration is the critical storm duration. This is discussed under Section 10.1.4.
4) The ration of runoff rate to ranifall intensity, C, is uniform during the storm duration.
5) Rainfall intensity is uniform during the storm duration.
6) The contributing area is the area that drains to the point of interest within the critical time of concentration.

10.1.2 Rational Method Runoff Coefficient (C)

In relating peak rainfall rates to peak discharges, the runoff coefficient "C" in the Rational Formula is dependent on the character of the surface of the drainage area. The rate and volume of runoff that reaches a storm drainage system depends on the relative porosity **(imperviousness),** ponding character, slope, and conveyance properties of the surface. Soil type, vegetative condition, and the presence of impervious surfaces, such as asphalt pavements and the roofs of buildings, are the major determining factors in selecting an area's "C" factor. The type and condition of the surface determines its ability to absorb precipitation and transport runoff.

The rate at which a soil absorbs precipitation generally decreases as rainfall continues for an extended period of time. The soil absorption or infiltration rate is also influenced by the presence of soil moisture before a rain **(antecedent precipitation),** the rainfall intensity, the depth of the ground water table, the degree of soil compaction, the porosity of the subsoil, vegetation, ground slopes, depressions, and storage. On-site inspections and aerial photographs may prove valuable in evaluating the nature of the surface within the drainage area.

The runoff coefficient "C" is difficult to precisely determine. Its use in the Rational Method implies a fixed ratio of runoff rate to rainfall intensity for any given drainage area, which in reality is not the case. A reasonable coefficient must be chosen to represent the integrated effects of infiltration, detention storage, evaporation, retention, flow routing, and interception, all of which affect the time distribution and peak rate of runoff. Proper use of the Rational Method requires judgment and experience on the part of the engineer, especially in the selection of the runoff coefficient.

Coefficients for specific surface types can be used to develop a composite runoff coefficient based in part on the percentage of different types of surfaces in the drainage area. This procedure is often applied to typical "sample" blocks as a guide to the selection of reasonable values of the coefficient for an entire area.

For the runoff coefficient "C" for various residential districts and specific surface types, refer to either Table 8.03b of the *Erosion and Sediment Control Planning and Design Manual*, the NCDOT *Guidelines for Drainage Studies and Hydraulic Design*, Table 3, or other approved recognized sources or publications of such data.

Most drainage areas will consist of several different types of development types. In these cases, the designer should develop a Composite Runoff Coefficient. The accepted procedure is simply to weight the individual coefficients according to the area taken by each category.

The Composite Runoff Coefficient is expressed as the following:

$$C_c = \frac{\sum (C_i A_i)}{\sum A_i} \qquad \text{Equation 10.1.2}$$

Where, C_c → The Composite Runoff Coefficient (dimensionless).

A_i → The area taken by an individual category of composition.

C_i → The runoff coefficient for the individual area.

10.1.3 Rational Method Rainfall Intensity (i)

Rainfall intensity (i) is the average rainfall rate in inches per hour which is considered for a particular basin or sub-basin. The rainfall intensity is determined on the basis of design rainfall duration and design frequency of occurrence. The **design rainfall duration** is equal to the critical time of concentration for all portions of the drainage area under consideration that contribute flow to the point of interest. The **frequency of occurrence** used in design computations is a statistical variable that is established by design standards or chosen by the engineer as a design parameter. It is usually expressed in terms of the average storm recurrence interval in years.

See Table 2.1 for the Intensity-Duration-Frequency (IDF) Table for the Town of Clayton. Data is also presented as an IDF Curve in Table 2.2.

10.1.4 Time of Concentration (t_c)

The **time of concentration** used in the rational equation is the time of concentration for the entire drainage area upstream of the point of interest. The **critical time of concentration** is the time of concentration which results in the maximum peak runoff rate from all or part of the upstream drainage area at the point of interest. This may be equal to or less than the time of concentration. Runoff from a watershed usually reaches a peak at the time when the entire drainage area is contributing. However, the runoff rate may reach a peak prior to the time when the entire upstream drainage area is contributing. In such instances, only the portions of the drainage area able to contribute flow at the point of interest during the critical time of concentration should be used in determining the peak discharge.

The time of concentration is based on a relationship between the hydraulic length of the watershed and the height of the most remote point in the watershed above the point of interest. The Kirpich Equation [Bureau of Reclamation, 1974] defines the time of concentration and is expressed by the following equation:

$$t_c = \frac{\left[L^3 / H\right]^{0.385}}{128}$$ Equation 10.1.3

Where, t_c → The time of concentration, which is equal to the time it takes runoff to travel from the most remote point in the basin to the point of interest.

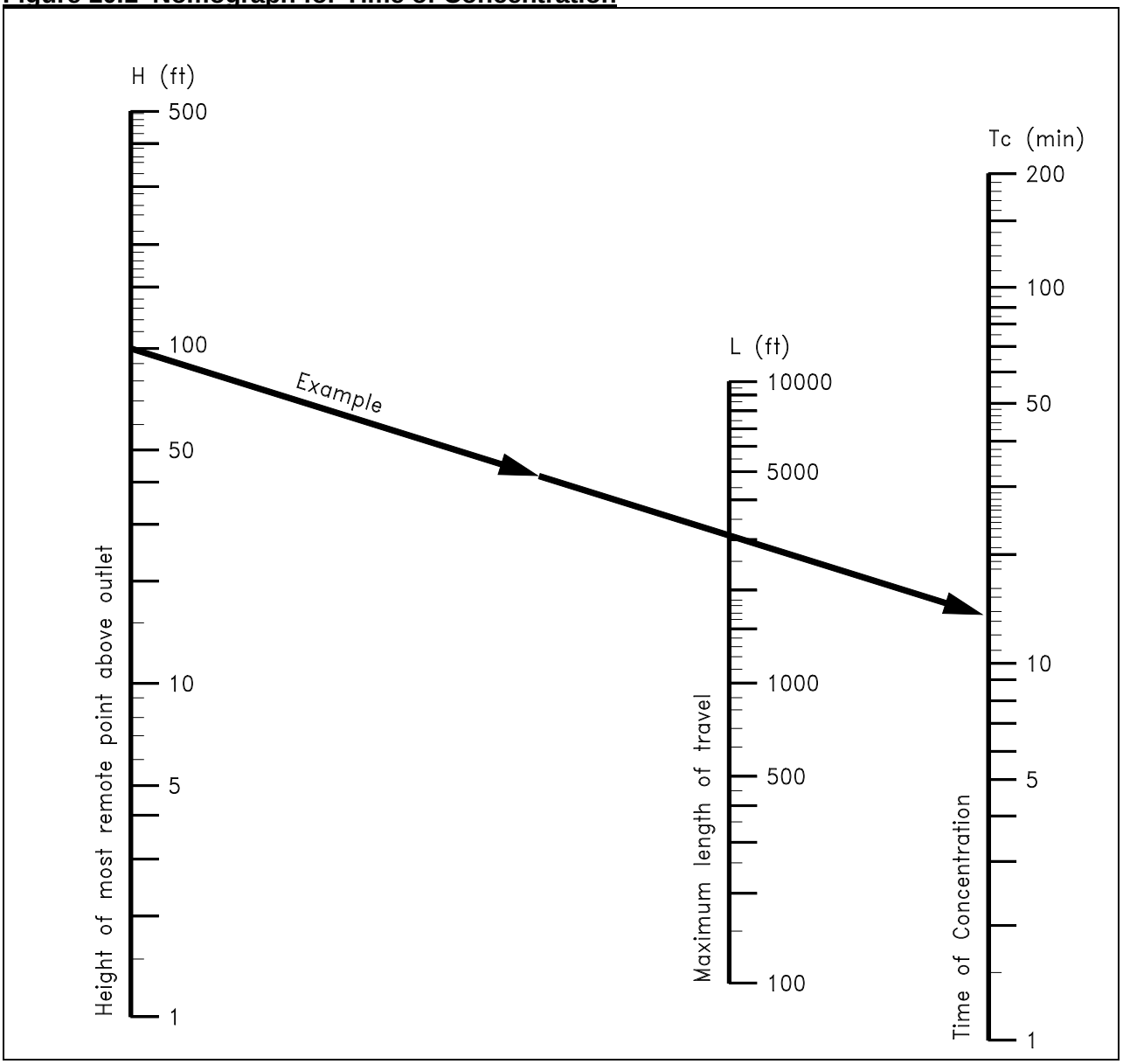
L → The hydraulic length of the watershed, which is the overland flow distance from the most remote point in the basin to the point of interest, measured in feet.

H → The height of the fall between the most remote point in the basin and the point of interest. The elevation difference along the hydraulic length, measured in feet.

Assuming the time of concentration equals the duration of the storm event in Table 2.2, The IDF curve can now be used to determine the rainfall intensity, (i). Storms of less than 15 minutes of duration are not considered in standard practice. In Clayton a time of concentration of 5 minutes can be assumed.

Figure 10.1 provides a nomograph to determine time of concentration.

Figure 10.1 Nomograph for Time of Concentration



Source: "E & S Control Planning and Design Manual," [DEHNR, May 1994 Revised]

Notes:

1) Use nomograph t_c for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.
2) For overland flow, grassed surfaces, multiply t_c by 2.
3) For overland flow, concrete or asphalt surfaces, multiply t_c by 0.4.
4) For concrete channels, multiply t_c by 0.2.

10.1.6 Rational Method Drainage Area (A)

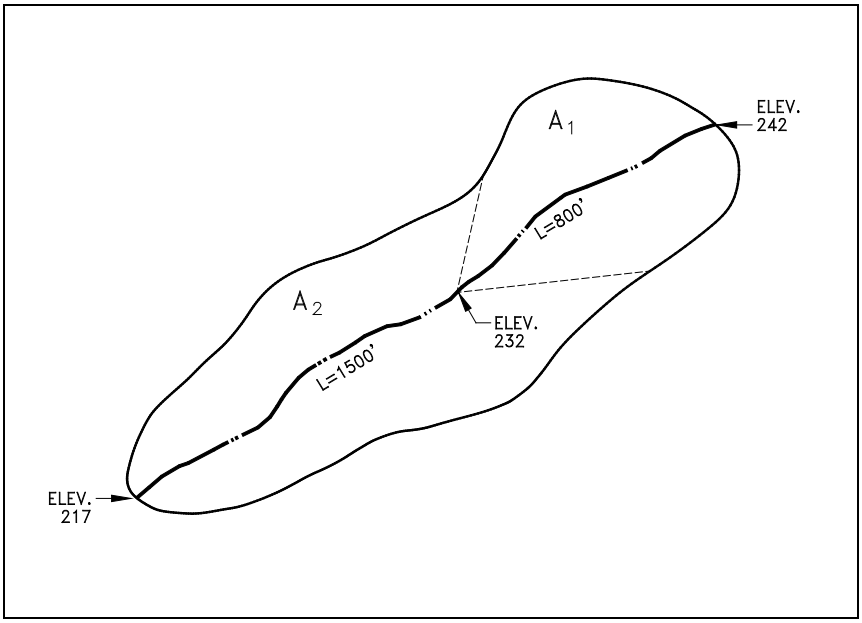
As mentioned previously, the drainage area used in determining peak discharges is the portion of the area that contributes flow to the point of interest within the critical time of concentration. The boundaries of the drainage area may be determined through the use of topographic maps, supplemented by field surveys where topographic data has changed or where the contour interval is too great to distinguish the direction of flow. A drainage area map shall be provided for each project. The drainage area contributing to the system being designed and the drainage sub-area contributing to each inlet point shall be identified. The boundaries of each drainage area must follow actual drainage divides rather than artificial land divisions as used in the design of sanitary sewers. The drainage divide lines are determined by pavement slopes, downspout locations, grading of lawns, and many other features that are introduced by the urbanization process

10.1.7 Overview of Rational Method Analysis [Malcom, 1989]

The following are the steps to be taken in determining the peak discharge for a particular point of interest:

1) Delineate the watershed contributing to the point of interest and determine the drainage area in acres. (The terms “watershed” and “drainage area” are synonymous.)
2) Determine the time of concentration for the watershed.
3) Determine the rainfall intensity for the designated return period at the time of concentration.
4) Determine the composite runoff coefficient.
5) Apply the Rational Equation to obtain the peak discharge.

Example 10.1



Example 10.1

Use the Rational Method to find the 10 year design runoff for the area shown above.
This is a hypothetical drainage system.

A1 → Basin Area = 5 acres
Multi-Family Residential District

A2 → Basin Area = 10 acres
Business District

Solution:

1. Time of Concentration: Using Equation 10.1.3 and the given information determine the time of concentration (t_c).

   Area A_1:

$$t_c = \frac{\left[L^3/H\right]^{0.385}}{128} = \frac{\left[800^3/(242-232)\right]^{0.385}}{128} = 7.26 \text{ min}$$

   Area A_2:

$$t_c = \frac{\left[L^3/H\right]^{0.385}}{128} = \frac{\left[1500^3/(232-217)\right]^{0.385}}{128} = 12.83 \text{ min}$$

   Therefore, the total time of concentration for the entire basin is 7.26 + 12.83 = 20.09 minutes, use 20 minutes. In lieu of using Equation 10.1.3, the Kirpich Equation, Figure 10.1 could have been used to graphically solve for the Time of Concentration.

2. Rainfall Intensity: Using the IDF curve, Figure 2.3, and the above calculated t_c = 20 minutes, *assuming the time of concentration (t_c) is equal to the duration (T) of the storm,* determine the Rainfall Intensity (10-yr Storm).

$$i = 4.64 \text{ inches/hour}$$

3. Runoff Coefficient:

   Using Equation 10.1.2, determine the composite "C" factor.

$$C_c = \frac{\sum(C_i A_i)}{\sum A_i} = \frac{(0.60x5)+(0.80x10)}{(5+10)} = 0.73$$

4. Calculate the 10 year design storm peak runoff:

   Using Equation 10.1.1 and the above solved equations, determine the peak flow runoff (10-yr Storm).

$$Q = CiA = 0.73 \text{ x } 4.64 \text{ x } 15 = \textbf{50.81 cfs}$$

10.2 CALCULATING RUNOFF – SCS METHOD

Situations requiring a complete flood hydrograph, and not just peak discharge, SCS TR-20 method should be used to determine total volume of runoff.

The total volume of runoff is dependent on the characteristics of the soil and the degree of urbanization of the area (i.e. percent of impervious cover). Loss rate totals may be estimated using the **SCS Curve Number** methodology developed by the Soil Conservation Service [SCS, 1972].

Figure 10.2 provides graphs for the determination of runoff volume for a given rainfall depth and SCS Curve Number.

The SCS provides information on relating soil group type to curve number as a function of soil cover, land use type and antecedent moisture conditions. The SCS soil classification system uses four groups, as follows:

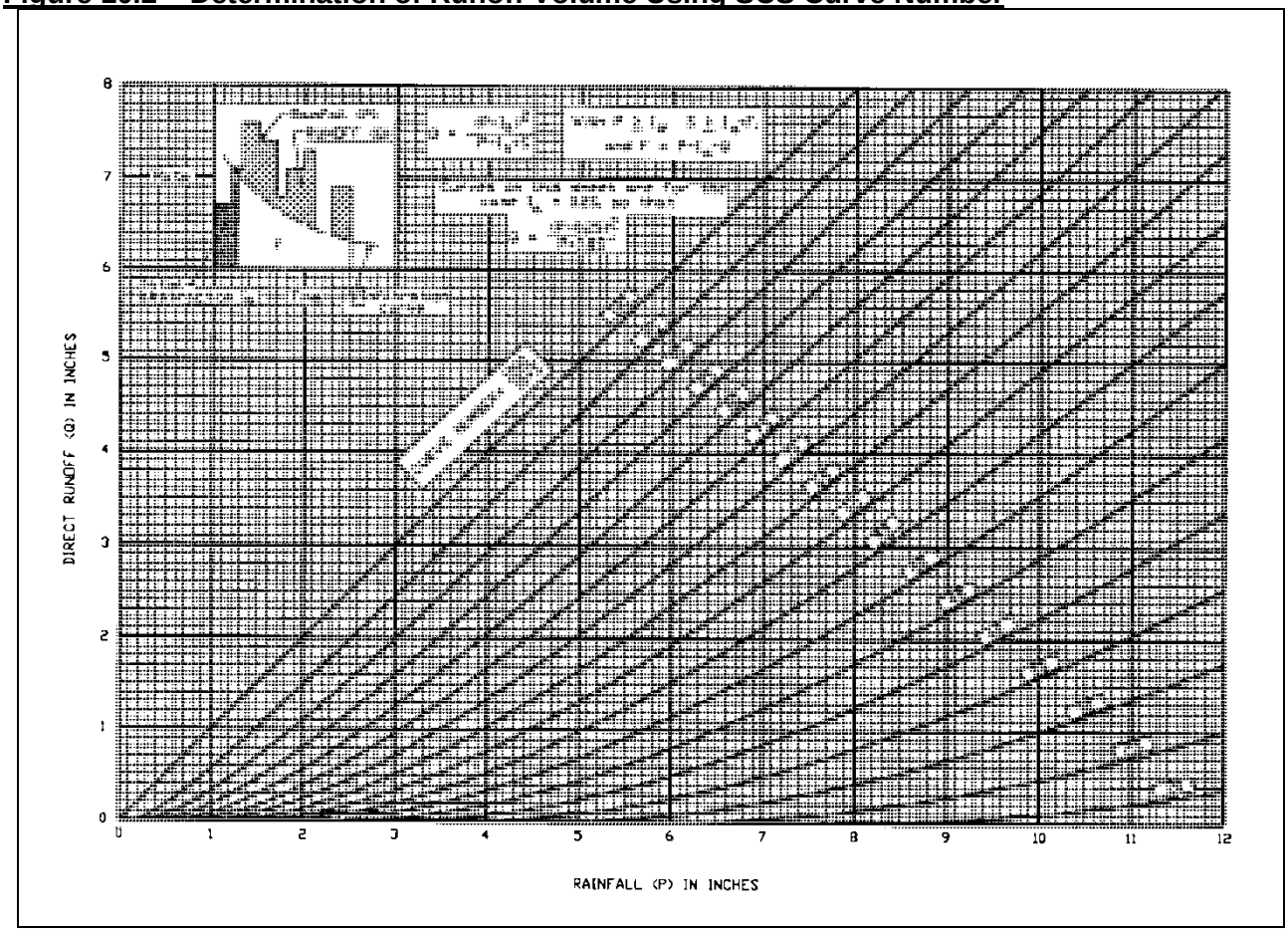
Group A:	deep sand, deep loess, aggregated silts
Group B:	shallow loess, sandy loam
Group C:	clay loams, shallow sandy loam, soils low in organic content, soils usually high in clay
Group D	soils that swell significantly when wet, heavy plastic clays, certain saline soils

All other factors being equal, Group A soils have the lowest runoff potential and Group D soils have the highest runoff potential.

Usually, the best source of information for determining the SCS soil group for a particular drainage area is the *Soil Survey of Johnston County, North Carolina* [SCS].

Refer to the NCDEQ *Erosion and Sediment Control Design Manual*, Tables 8.03e through 8.03g for the SCS Curve Numbers for each of the four SCS soil groups. The tables are also organized according to the SCS cover complex, which consists of three factors: land use, land treatment or practice, and hydrologic condition. For example, the land use for a particular area may be "Row crops". If the land treatment or practice is "Straight row" and the hydrologic condition is "Good", then the SCS Curve Number would range from 67 to 89, depending on the soil group.

Figure 10.2 Determination of Runoff Volume Using SCS Curve Number



Source: "Drainage Criteria Manual for Montgomery County Texas," [Dodson, 1989]

$$S = \frac{1000}{CN} - 10$$ Equation 10.2.1

$$Q^* = \frac{(P - 0.2S)^2}{P + 0.8S}$$ Equation 10.2.2

The Volume of runoff is now found by multiplying runoff depth by the watershed area.

$$V = Q^* A$$ Equation 10.2.3

Where, S → Ultimate Soil Storage, measured in inches.

P → Precipitation depth, measured in inches. The depth of precipitation varies from any given Storm Event. To determine inches of rainfall, the designer should use *Technical Paper Number 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years*, [Hershfield, 1961].

Q^* → The runoff depth, measured in inches. The asterisk has been added to distinguish the use of Q^*, which is a depth and the usual use of Q, which is a discharge.

V → The total volume of runoff for the design storm in cubic feet.

A → The area in acres contributing runoff to the point of interest . The area in these equations is to measured in SQUARE MILES.

Example 10.2

Use the SCS Method to determine the total volume of runoff for the following given data for the 10-yr, 24-hr storm. The basin size is 300 acres (0.469 Square Miles). The composite CN is 80. *This is a hypothetical system.*

Solution:

Estimate the Runoff Volume:

a. Use TP-40 (Table 2.2) to determine the depth of rainfall for the 10 year -24 hour Storm.

$$P_{10,24} = 5.44 \text{ inches}$$

b. Using Equation 10.2.1, Equation 10.2.2, Equation 10.2.3 and the above given information determine the Runoff Volume.

$$S = \frac{1000}{CN} - 10 = \frac{1000}{80} - 10 = 2.5 \text{ inches}$$

$$Q^* = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{(5.44 - 0.2(2.5))^2}{5.44 + 0.8(2.5)} = 3.28 \text{ inches}$$

$$V = Q^* A = (3.28)(300) = 984 \text{ acre-inches}$$

This volume can be used with Malcom's Method to develop the inflow hydrograph.

10.3 CULVERT DESIGN

As described in Section 4.5.3, the Town of Clayton uses the design procedures of Hydraulic Engineering Circular No. 5 (*HEC 5*) for the design of pipe culverts. *HEC 5* was designed to analyze flow in pipes using many different variables. These variables, which affect the hydraulic capacity of a culvert, cause the pipe system to function as either an inlet-controlled pipe section or an outlet-controlled pipe section. ***Inlet control*** means that the discharge in the culvert is limited by the hydraulic and physical characteristics of the inlet alone. These include headwater depth, culvert barrel shape, barrel cross sectional area, and the type of inlet edge. For inlet control, the barrel roughness, length, and slope are not factors in determining culvert capacity.

Under ***outlet control*****,** the discharge capacity of the culvert is dependent on all of the hydraulic variables of the structure. These include headwater depth, tailwater depth, barrel shape, cross-sectional area, barrel roughness, slope, and length.

In all culvert design, ***headwater*****,** or depth of ponding at the entrance to the culvert is an important factor in culvert capacity. The headwater depth (HW) is the vertical distance from the invert at the culvert entrance to the energy grade line of the approaching flow. Due to low velocities in most entrance pools and the difficulty in determining velocity head in any flow, the energy line can often be assumed be the same as the water surface.

For culverts under outlet control, ***tailwater depth*** is an important factor in computing both headwater depth and the hydraulic capacity of the culvert. If flow in the channel downstream of the culvert is sub-critical, a computer-aided backwater analysis or calculation of normal depth is warranted to determine the tailwater elevation. If the downstream flow is super-critical, tailwater depth is not a factor in determining the culvert's hydraulic capacity.

10.3.1 Inlet-Controlled Flow

Under inlet control, the culvert entrance may or may not be submerged. However, inlet-controlled flow through the culvert barrel is free surface flow in all cases. When the culvert inlet is submerged, the most reliable means for determining discharge is with standard empirical relationships. Nomographs which plot headwater vs. discharge for various culvert sizes and shapes under inlet control have been developed on the basis of laboratory research with models and full scale prototypes (Figure 10.3.4).

10.3.2 Outlet-Controlled Flow

The culvert barrel may be full or partially full for culverts with outlet control flow for part or all of the barrel length. Both the headwater and tailwater may or may not submerge the culvert.

If the culvert is flowing full, the energy required to pass a given quantity of water is stored in the head (H). From energy considerations it can be shown that H is the difference between the hydraulic grade line at the outlet and the energy grade line at the inlet (expressed in feet).

When a given discharge passes through a culvert, stored energy, represented by the total head (H), is dissipated in three ways: A portion is lost to turbulence at the entrance (H_e); a portion is lost to frictional resistance in the culvert barrel (H_f); and a portion is lost as the kinetic energy of flow through the culvert dissipated in the tailwater (H_o). From this, the following relationship is evident:

$$H = H_e + H_f + H_o \qquad \text{Equation 10.3.1}$$

The entrance loss (H_e) is determined by multiplying the culvert velocity head by an entrance loss coefficient k_e. Table 10.3 lists values for the entrance loss coefficient.

Table 10.3 Entrance Loss Coefficients for Concrete Pipe Culverts

Type of Structure and Design of Entrance	Coefficient
Projecting from fill, socket end (groove-end)	0.20
Projecting from fill, square cut end	0.50
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.20
Square-edge	0.50
Rounded (radius = 0.5D)	0.20
Mitered to conform to fill slope	0.70
End section conforming to fill slope	0.50
Beveled edges (33.7 degree or 45 degree bevels)	0.20
Side- or slope-tapered Inlet	0.20

Source: [FHWA, 1985]

The exit loss (H_o) is generally set equal to the culvert velocity head and the downstream flow velocity is assumed to be zero. An expression for the friction loss (H_f) is derived from Manning's equation:

$$H_f = \left(\frac{29n^2L}{R^{1.33}}\right)\frac{V^2}{2g} \qquad \text{Equation 10.3.2}$$

Where, n → Manning's roughness coefficient.

L → The culvert barrel length, measured in feet.

R → The hydraulic radius, measured in feet.

g → The gravitational constant ($32.2\ ft/\sec^2$).

V → The mean velocity of flow in the culvert, measured in $ft/\sec$.

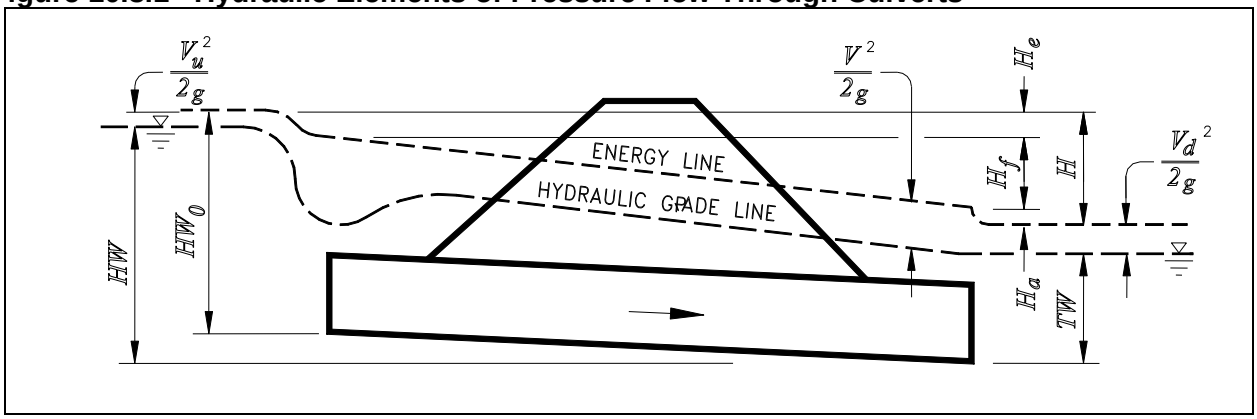
Rearranging Equation 10.3.1 and substituting it into Equation 10.3.2, it is seen that for full flow:

$$H = 1 + k_e + \left(\frac{29n^2L}{R^{1.33}}\right)\frac{V^2}{2(32.2)} \qquad \text{Equation 10.3.3}$$

Equation 10.3.3 may be solved using the full flow nomographs, Figures 10.3.4 and 10.3.5. Each nomograph is drawn for a particular barrel shape and material and a single value of Manning's "

n" as noted on the respective charts. These nomographs may be used for other values of "n" by modifying the culvert length as directed in the instructions for use of the full-flow nomographs.

Figure 10.3.1 Hydraulic Elements of Pressure Flow Through Culverts



Source: [FHWA, 1985]

Figure 10.3.1 represents the various hydraulic elements of pressure, or full, flow through a culvert and reveals graphically that the head (H) is equivalent to the vertical distance between the energy grade line at the inlet and the energy grade line at the outlet. It also reveals the following relationship for full flow conditions:

$$H = H_e + H_f + H_o = HW + SL - \frac{V^2}{2g} - TW \qquad \text{Equation 10.3.4}$$

Where, HW → The headwater depth, measured in feet.

TW → The tailwater depth above the invert of the culvert outlet, measured in feet.

S_o → The culvert barrel slope, measured in feet/feet.

If the downstream flow velocity is neglected, Equation 10.3.4 becomes:

$$H = HW + S_o L - TW \qquad \text{Equation 10.3.5}$$

In culvert design it is generally required that the depth of the headwater (HW) be determined.

Rearranging Equation 10.3.5, the following expression for HW is derived:

$$HW = H + TW - LS_o \qquad \text{Equation 10.3.6}$$

When the culvert outlet is submerged by the tailwater, the above equation can be solved directly to determine HW. However, when the tailwater is below the crown of the culvert, it becomes necessary to redefine d_2, which is taken as the greater of the following two values:

1) TW

2) $\left(d_c + D\right)/2$

Where, d_c → The critical depth in the culvert as read from the appropriate chart, measured in feet.

TW → The tailwater depth above the invert of the culvert outlet, measured in feet.

D → The height of the culvert, measured in feet.

Step by Step Culvert Design Procedure

It is possible by solving complex hydraulic computations to determine the probable type of flow under which a culvert will operate for a given set of conditions. However, such computations can be avoided by determining the headwater necessary for a given discharge under both inlet and outlet flow conditions. The larger of the two will define the type of control and the corresponding headwater depth.

The culvert design procedures presented here are based on information provided in the Federal Highway Administration publication *Hydraulic Design of Highway Culverts* [FHWA, 1985]. Figures 10.3.3 to 10.3.5 cover a range of pipe and box culverts commonly used in drainage design. These nomographs correspond to Charts 1 through 15 and 29 through 40 in *Hydraulic Design of Highway Culverts,* [FHWA,1985].

The following is the recommended procedure for selection of culvert size:

Step 1: List design data.

a) Design discharge (Q), in cfs, with return period.

b) Approximate length (L) of culvert, in feet.

c) Slope of culvert (S_o). If grade is given in percent, convert to slope in feet per feet.

d) Allowable headwater depth, in feet, which is the vertical distance from the culvert invert (flow-line) at the entrance to the water surface elevation permissible in the headwater pool or approach channel upstream from the culvert.

e) Flow velocities in the channel upstream and downstream of the proposed culvert location.

f) Type of culvert for first trial selection, including barrel material, barrel cross-sectional shape and entrance type.

Step 2: Determine the first trial culvert size.

Since the procedure given is one of trial and error, the initial trial size can be determined in several ways:

a) Past experience and engineering judgment.

b) By using an approximating equation such as $Q/6 = A$ from which the trial culvert dimensions are determined. "A" is the culvert barrel cross-sectional area and 6 is an estimate of barrel velocity in feet per second.

c) Initially, utilize the inlet control nomographs for the culvert type selected. An HW/D ratio must be assumed, say HW/D = 1.5, along with the given Q to determine a trial culvert size.

If any trial size is too large in dimension because of limited height of embankment or availability of size, multiple culverts may be used by dividing the discharge appropriately among the number of barrels used. Raising the embankment height or the use of pipe arch and box culverts with width greater than height should also be considered. Final selection should be based on applicability and costs.

Step 3: Find headwater depth for trial culvert size.

a) Assuming Inlet Control

1) Using the trial size from Step 2, find the headwater depth (HW) by use of the appropriate inlet control nomograph. Tailwater (TW) conditions are to be neglected in this determination. HW in this case is found by multiplying HW/D obtained from the nomographs by the height of culvert (D).

2) If HW is greater or less than allowable, try another trial size until HW is acceptable for inlet control before computing HW for outlet control.

b) Assuming Outlet Control

1) Approximate the depth of tailwater (TW), in feet, above the invert at the outlet for the design flood condition in the outlet channel.

2) For tailwater (TW) elevation equal to or greater than the top of the culvert at the outlet, set d_2 equal to TW and find HW by using Equation 10.3.7.

$$HW = H + TW - LS_o \qquad \text{Equation 10.3.7}$$

3) For tailwater (TW) elevations less than the top of the culvert at the outlet, find headwater (HW) by Equation 10.3.7 as in Step b(2) above except that:

$d_2 = (d_c + D)/2$ or TW (whichever is greater)

Note: Headwater depth determined in Step b(3) becomes increasingly less accurate as the headwater computed by this method falls below the value:

$$D + (1 + k_e)\frac{V^2}{2g}$$

c) Compare the headwater depths obtained in Step 3(a) and Step 3(b) (Inlet Control and Outlet Control). The higher headwater governs and indicates the flow control existing under the given conditions for the trial size selected.

d) If outlet control governs and the HW is higher than is acceptable, select a larger trial size and find HW as instructed under Step 3(b). (Inlet control need not be checked, since the smaller size was satisfactory for this control as determined under Step 3(a).)

Step 4: Try additional culvert types or shapes.

Determine their size and HW by the above procedure.

Step 5: Compute outlet velocities for size and types of Culverts to be considered in selection and determine need for channel protection.

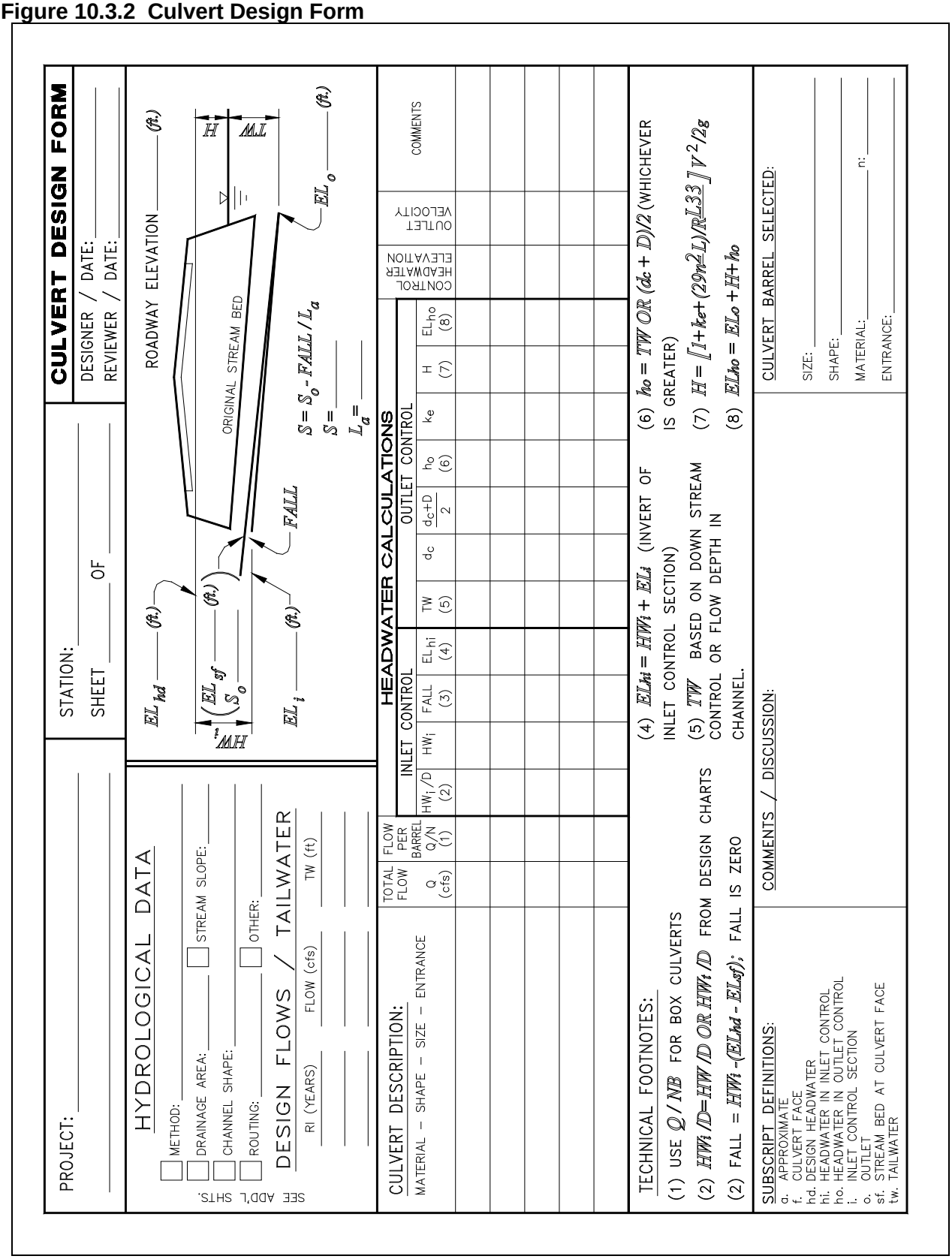
a) If outlet control governs in Step 3(c) above, outlet velocity equals Q/A_0, where A_0 is the cross-sectional area of flow in the culvert barrel at the outlet. If d_c or TW is less than the height of the culvert barrel, use A_0 corresponding to d_c or TW depth, depending on whichever gives the greater area of flow. A_0 should not exceed the total cross-sectional area A of the culvert barrel.

b) If inlet control governs in Step 3(c), outlet velocity can be assumed to equal mean velocity (V) in open-channel type flow as computed by Manning's equation for the rate of flow, barrel size, roughness and slope of culvert selected.

Step 6: Record final selection of culvert with size, type, allowed and computed headwater, outlet velocity and economic justification.

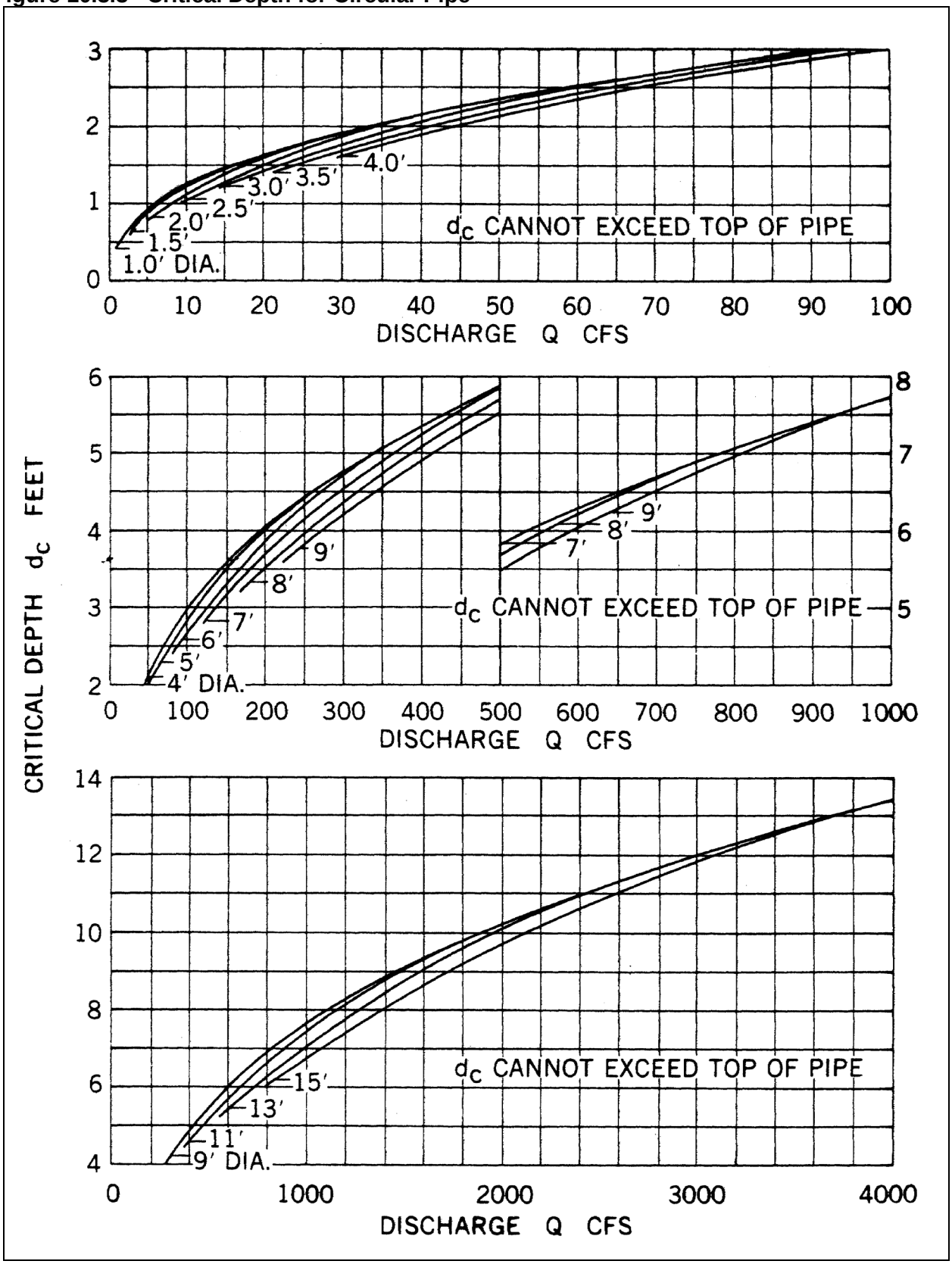
Figure 10.3.2 provides a Culvert Design Form that may be used to record the culvert computations and related data.

Figure 10.3.2 Culvert Design Form



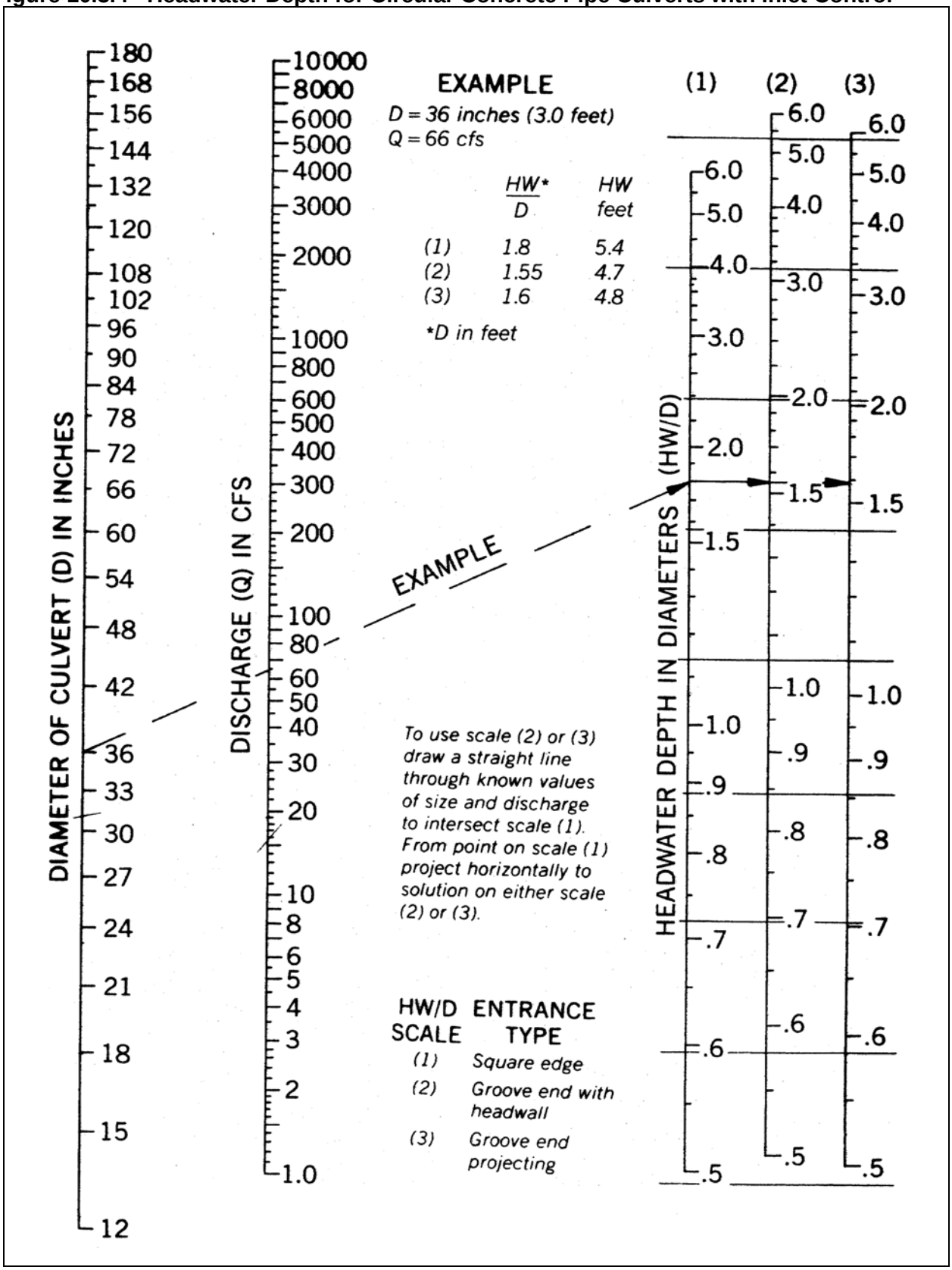
Source: "Drainage Criteria Manual for Montgomery County, Texas," [Dodson, 1989]

Figure 10.3.3 Critical Depth for Circular Pipe



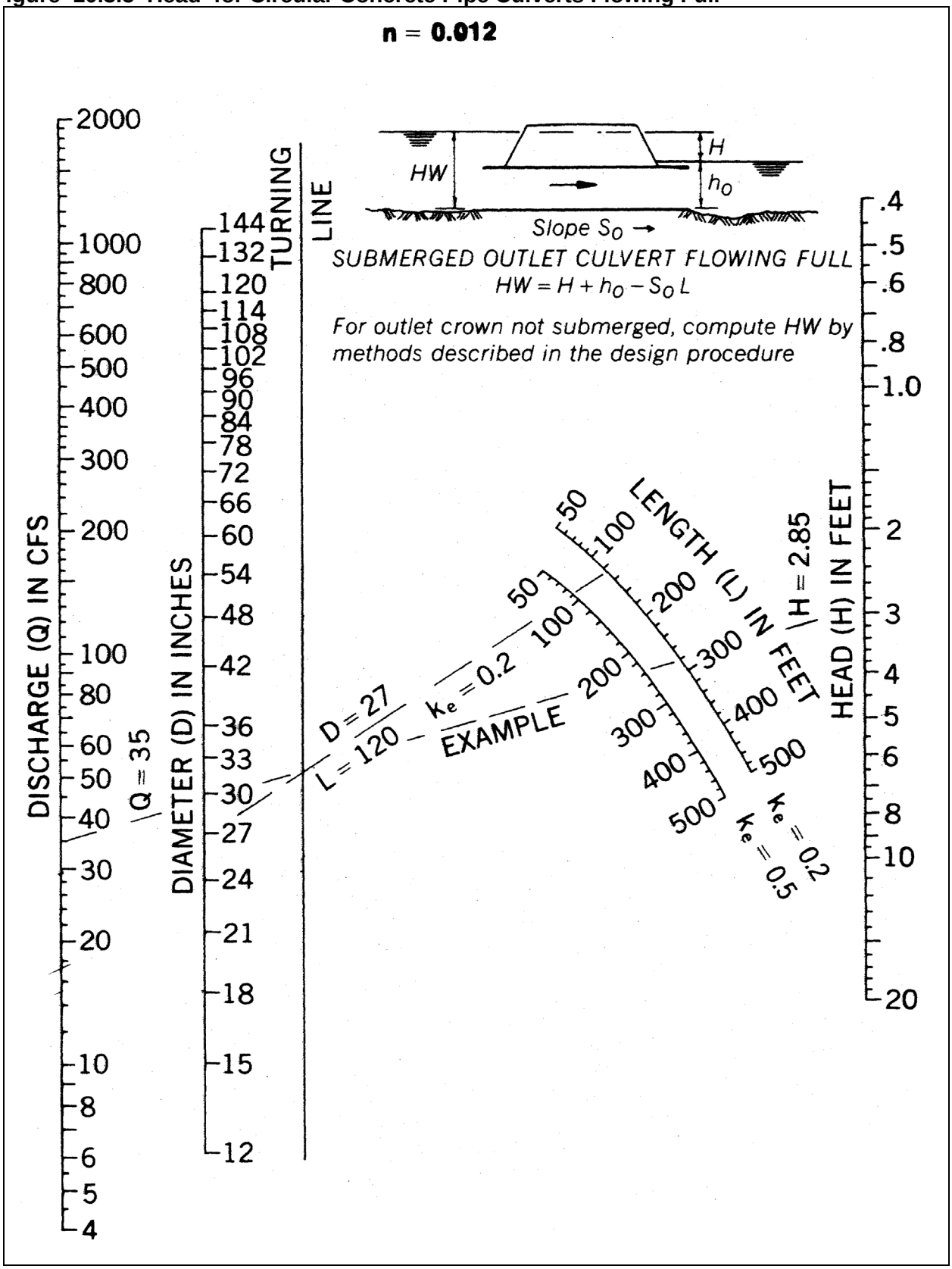
Source: [Bureau of Public Roads, 1963]

Figure 10.3.4 Headwater Depth for Circular Concrete Pipe Culverts with Inlet Control



Source: [Bureau of Public Roads, 1963]

Figure 10.3.5 Head for Circular Concrete Pipe Culverts Flowing Full



Source: [Bureau of Public Roads, 1963]

10.4 CURB INLET DESIGN – GUTTER SPREAD

As described in Section 4.6, the Town of Clayton uses the design procedures of USDOT Federal Highway Administration *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, Chapter 4, as applicable, for curb inlet design. *HEC 22* was designed to analyze flow in gutters and the interception capacity of grate, curb-opening and slotted drain inlets as well as combination inlets.

The curb inlet design procedure is based on the standard Town of Clayton curb inlet. Inlets capture most of the water entering the pipe system. The following procedure is used to locate inlets, however, other factors shall be considered such as location of the low points, intersections and layout of the pipe system (See Section 3.6 and Section 4.6).

a. Determine the maximum gutter flow from the nomograph "Flow in triangular gutter sections" (Figure 10.4.1). The known values of S = Street longitudinal slope, S_x = Street cross slope, T = 6 feet (the maximum allowable spread), and n = Manning's roughness coefficient are used to solve for the gutter capacity, Q.

b. Determine the location of the inlet using the rational formula rearranged such that:

$$A = \frac{Q}{Ci} \qquad \text{Equation 10.4.1}$$

Where, Q → The peak rate of runoff in cubic feet per second (cfs). Actually, Q is in units of inches per hour per acre.

C → The dimensionless coefficient of runoff representing the ratio of peak discharge per acre to rainfall intensity (i).

i → The average intensity of rainfall in inches per hour for a period of time equal to the time of concentration for the drainage area at the point of interest.

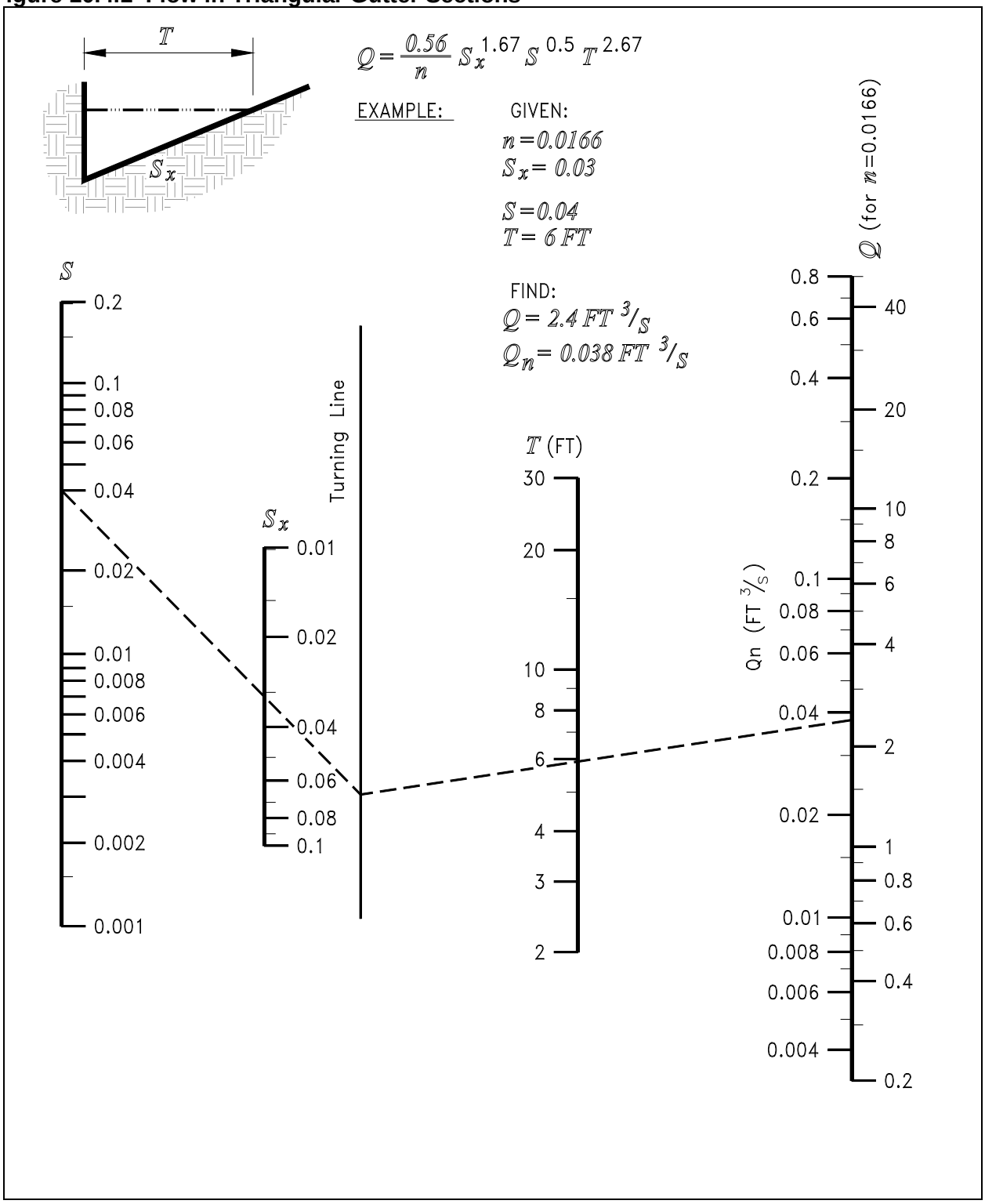
A → The area in acres contributing runoff to the point of interest during the critical storm duration.

Locate the first inlet by trial and error using the existing site contours and the proposed designed plan such that the area of the sub-drainage area does not exceed the capacity determined using Equation 10.4.1. Remember to check the "C" value for the actual area determined.

c. The next inlets are located utilizing Figure 10.4.1 and 10.4.2. Determine the required curb opening length, L_t, and enter in Figure 10.4.3, with the ratio L/L_t where L is the actual curb opening in feet for Town of Clayton standard curb inlets. This will yield the percentage of flow intercepted by each basin. The remainder of this flow shall be considered in determining the location of the next downstream inlet. This procedure

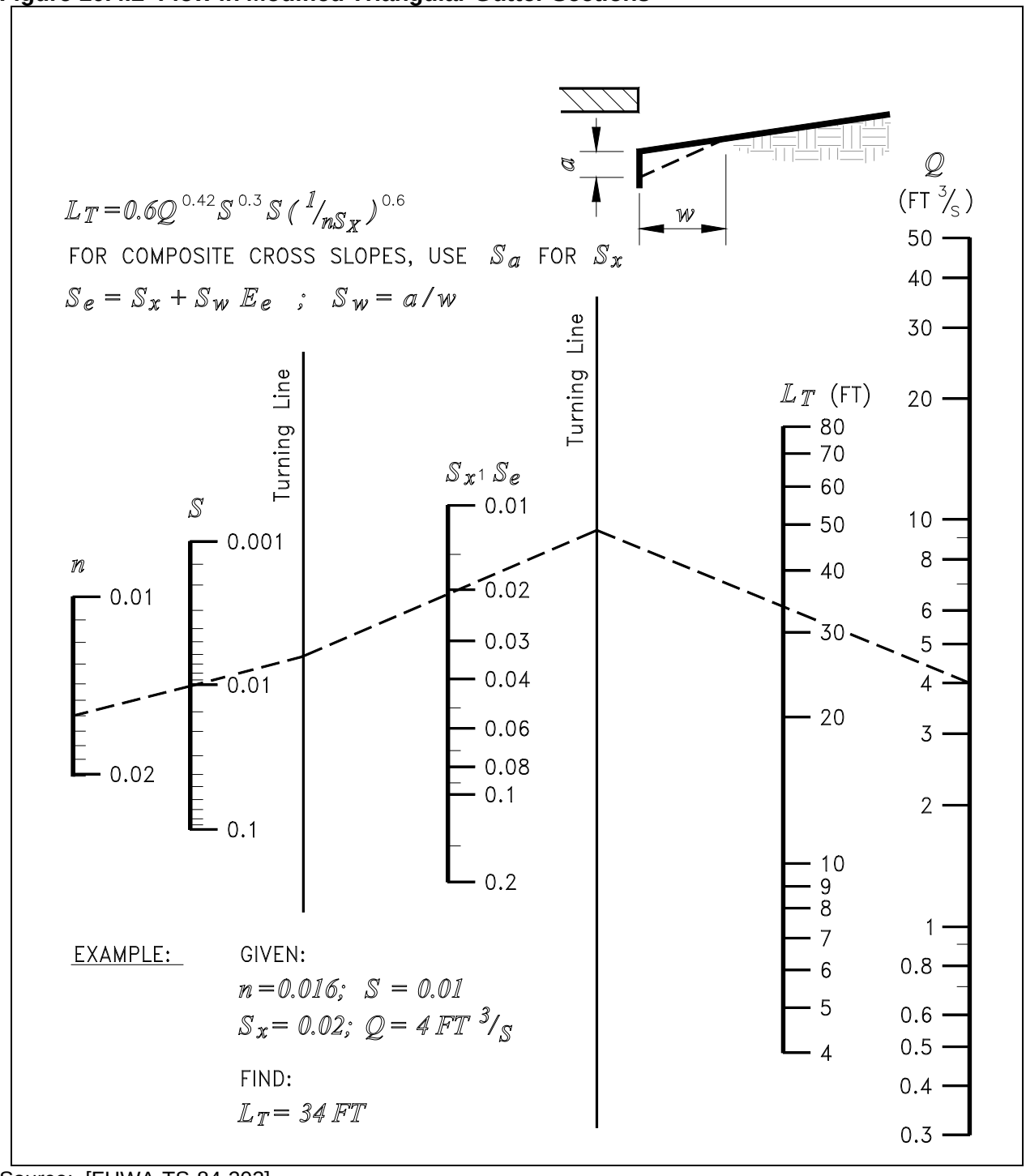
is repeated as necessary. Do not exceed the maximum pipe run length between structures as noted in Table 3.3 (Section 3.6).

Figure 10.4.1 Flow in Triangular Gutter Sections



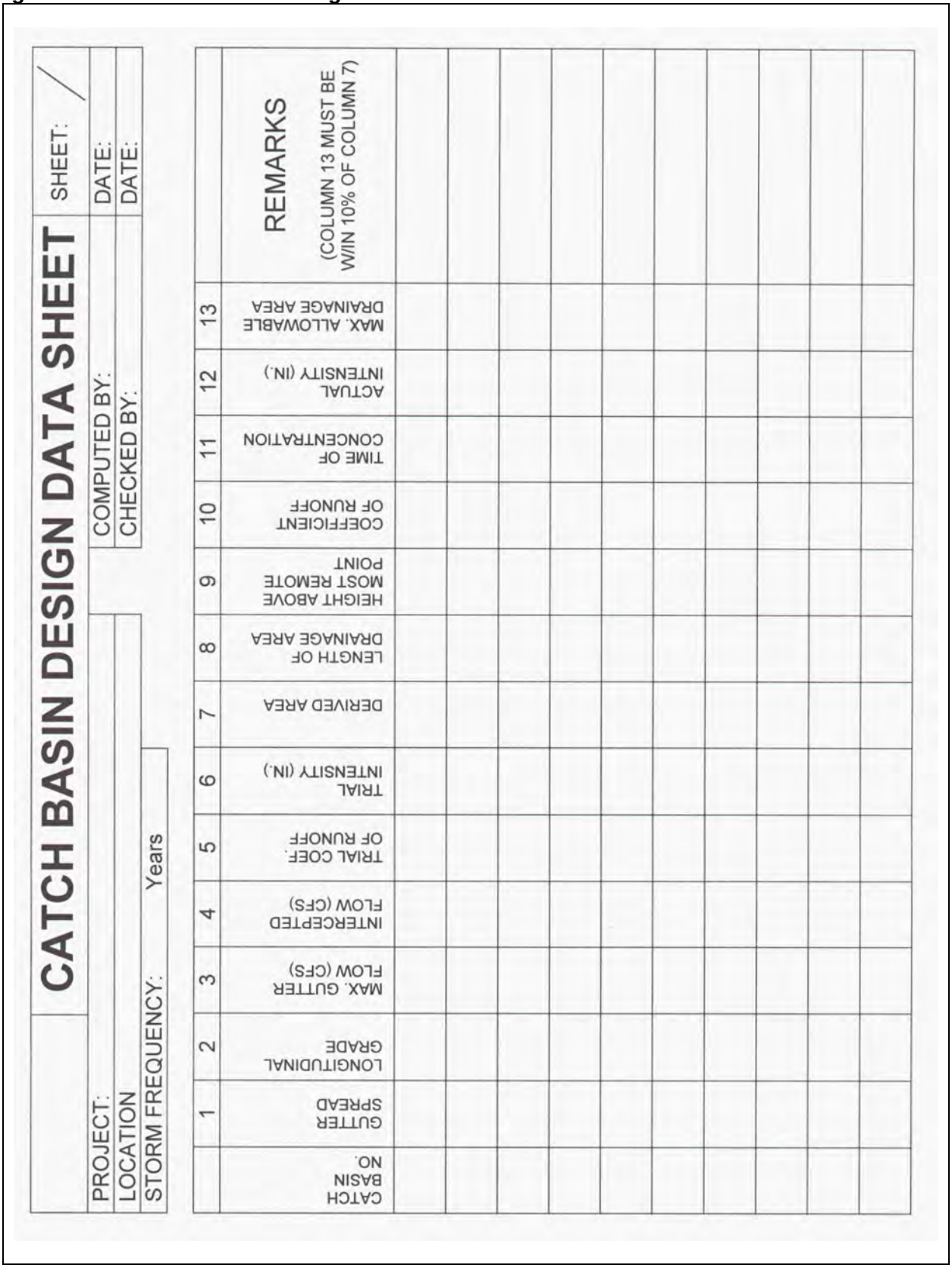
Source: [FHWA-TS-84-202]

Figure 10.4.2 Flow in Modified Triangular Gutter Sections



Source: [FHWA-TS-84-202]

Figure 10.4.3 Catch Basin Design Data Sheet



Source: City of Wilmington Technical Standards and Design, [July 1996]

10.5 OPEN CHANNEL DESIGN

As described in Section 5.2, the proper hydraulic design of a channel is primary importance to ensure that flooding, sedimentation and erosion do not occur.

10.5.1 THE MANNING EQUATION

The Manning equation is an empirical relationship which relates friction slope, flow depth, channel roughness, and channel cross-sectional shape to flow rate. The ***friction slope*** is a measure of the rate at which energy is being lost due to channel resistance. When the channel slope and the friction slope are equal ($S_f = S_o$), the flow is uniform and the Manning equation may be used to determine the depth for uniform flow, commonly known as the ***normal depth*.**

The Manning equation is as follows:

$$V = \left(\frac{1.49}{n}\right) R^{2/3} \sqrt{S_f} \qquad \text{Equation 10.5.1}$$

or

$$Q = \left(\frac{1.49}{n}\right) A R^{2/3} \sqrt{S_f} \qquad \text{Equation 10.5.2}$$

Where, Q → Total discharge (cfs)

V → Velocity of flow (ft/sec)

n → Manning coefficient of roughness (dimensionless), an experimentally determined value which is a function of the nature of the channel lining (Table 10.5.1).

A → Cross-sectional area of the flow (ft^2)

R → Hydraulic radius of the channel (ft) (flow area/wetted perimeter). Wetted perimeter is the distance along the perimeter of the cross section against which water is flowing. It DOES NOT include the free water surface.

S_f → Friction slope, the rate at which energy is lost due to channel resistance. Longitudinal slope of the water surface (feet fall/feet run). If flow is uniform, it is also the slope of the invert of the channel.

The area (A) and the hydraulic radius (R) are written in terms of the depth (y_o). Knowing the discharge (Q), Manning "n" value, and the channel slope (S_o), Equation 4.02 can be solved by trial to find normal depth (y_o).

10.5.1.1 Manning 'n' Values

The Manning "n" value is an experimentally derived constant which represents the effect of channel roughness in the Manning equation. Considerable care must be given to the selection of an appropriate "n" value for a given channel due to its significant effect on the results of the Manning equation. Tables 10.5.1 through 10.5.5 provide a listing of "n" values for various channel conditions.

Table 10.5.1 Manning Roughness Coefficient for Excavated or Dredged Channels

Type of Channel and Description	Minimum	Normal	Maximum
Earth, straight and uniform			
Clean, recently completed	0.016	0.018	0.020
Clean, after weathering	0.019	0.022	0.025
Gravel, uniform section, clean	0.022	0.025	0.030
With short grass, few weeds	0.022	0.027	0.033
Earth, winding and sluggish			
No vegetation	0.023	0.025	0.030
Grass, some weeds	0.025	0.030	0.033
Dense weeds or plants in deep channels	0.030	0.035	0.040
Earth bottom and rubble sides	0.028	0.030	0.035
Stony bottom and weedy banks	0.025	0.035	0.040
Cobble bottom and clean sides	0.030	0.040	0.050
Dragline-excavated or dredged			
No vegetation	0.025	0.028	0.033
Light brush or banks	0.035	0.050	0.060
Rock cuts			
Smooth and uniform	0.025	0.035	0.040
Jagged and irregular	0.035	0.040	0.050
Channels not maintained and brush uncut			
Dense weeds, high as flow depth	0.050	0.080	0.012
Clean bottom, brush on sides	0.040	0.050	0.080
Same, highest stage of flow	0.045	0.070	0.110
Dense brush, high stage	0.080	0.100	0.140

Source: [Chow, 1959]

Table 10.5.2 Manning Roughness Coefficient for Lined or Built-Up Channels

Type of Channel and Description	Minimum	Normal	Maximum
Metal			
Unpainted Smooth steel surface	0.011	0.012	0.014
Painted smooth steel surface	0.012	0.013	0.017
Corrugated metal	0.021	0.025	0.030
Cement			
Neat, surface	0.010	0.011	0.013
Mortar	0.011	0.013	0.015
Wood			
Planed, untreated	0.010	0.012	0.014
Planed, creosoted	0.011	0.012	0.015
Unplaned	0.011	0.013	0.015
Wood plank with battens	0.012	0.015	0.018
Concrete			
Trowel finish	0.011	0.013	0.015
Float finish	0.013	0.015	0.016
Finished, with gravel on bottom	0.015	0.017	0.020
Unfinished	0.014	0.017	0.020
Concrete on good excavated rock	0.018	0.020	---
Concrete on irregular excavated rock	0.022	0.027	---
Gravel bottom			
sides of Formed concrete	0.017	0.020	0.025
sides of Random stone in mortar	0.020	0.023	0.026
sides of Dry rubble or rip-rap	0.023	0.033	0.036
Brick			
Glazed	0.011	0.013	0.015
in cement mortar	0.012	0.015	0.018
Asphalt			
Smooth	0.013	0.013	---
Rough	0.016	0.016	---
Vegetated lining	0.030	---	0.500

Source: [Chow,1959]

Table 10.5.3 Manning Roughness Coefficient for Minor* Natural Streams

Type of Channel and Description	Minimum	Normal	Maximum
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but some stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of, timber and underbrush	0.075	0.100	0.150
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070

Source: [Chow, 1959] *Note: A "minor stream" is one which has a top width of less than 100 feet at flood stage.

Table 10.5.4 Manning Roughness Coefficient for Major* Natural Streams

Type of Channel and Description	Minimum	Normal	Maximum
Regular section with no boulders or brush	0.025	---	0.060
Irregular and rough section	0.035	---	0.100

Source: [Chow, 1959]

*Note: A **"**major stream" is one with a top width of more than 100 feet at flood stage. The n value is less than that for minor streams of similar description because banks offer less effective resistance.

Table 10.5.5 Manning Roughness Coefficient for Flood Plains

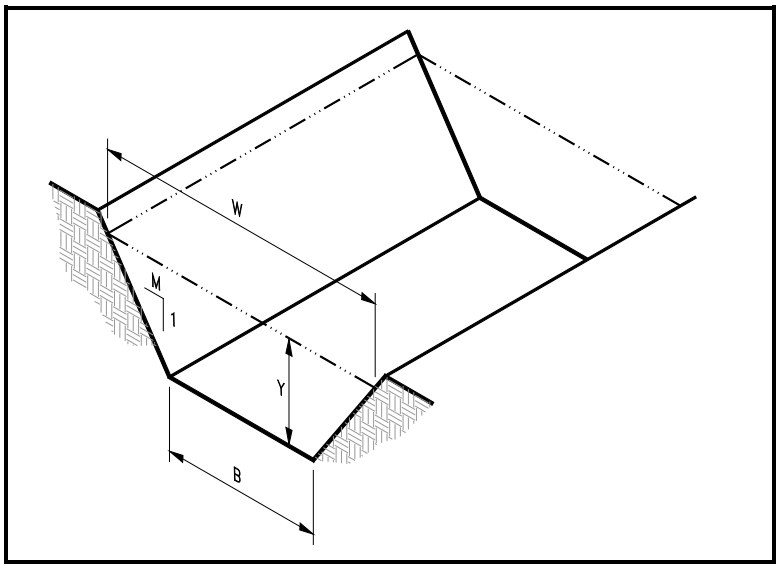
Type of Channel and Description	Minimum	Normal	Maximum
Pasture, no brush			
Short grass	0.025	0.030	0.035
High grass	0.030	0.035	0.050
Cultivated areas			
No crop	0.020	0.030	0.040
Mature row crops	0.025	0.035	0.045
Mature field crops	0.030	0.040	0.050
Brush			
Scattered brush, heavy weeds	0.035	0.050	0.070
Light brush and trees, in winter	0.035	0.050	0.060
Light brush and trees, in summer	0.040	0.060	0.080
Medium to dense brush, in winter	0.045	0.070	0.110
Medium to dense brush, in summer	0.070	0.100	0.160
Trees			
Dense willows, summer, straight	0.110	0.150	0.200
Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
Same as above, w/ heavy growth of sprouts	0.050	0.060	0.080
Heavy stand of timber, a few down trees, little undergrowth, flood-stage below branches	0.080	0.100	0.120
Same as above, w/ flood stage reaching branches	0.100	0.120	0.160

Source: [Chow, 1959]

10.5.2 TRAPEZOIDAL CHANNEL DESIGN

In trapezoidal design applications, Figure 10.5.1 and Equations 10.5.3 through 10.5.6 help define the variables used to solve the Manning equation.

Figure 10.5.1 Typical Trapezoidal Channel



Where, W → Top width of flow, measured in feet.

B → Bottom width of the channel, measured in feet.

y → Depth of flow, measured in feet.

M → Side slope ratio (ft. horizontal / ft. vertical). (For a 2 to 1 side slope, the value of M is 2.)

P → Represents the wetted perimeter.

The following equations are derived geometrically, and the units of the variables are consistent with those given above:

$$A = By + M\,y^2 \qquad \text{Equation 10.5.3}$$

$$P = B + 2y\sqrt{(1 + M^2)} \qquad \text{Equation 10.5.4}$$

$$W = B + 2M\,y \qquad \text{Equation 10.5.5}$$

$$R = \frac{A}{P} \qquad \text{Equation 10.5.6}$$

10.5.3 MANNING ROUGHNESS COEFFICIENT – IMPROVED CHANNELS

The values of the Manning roughness coefficient listed in Table 10.5.6 should be used in the design of channel improvements. Alternative values should be discussed with the Engineering Director.

Table 10.5.6 Manning Roughness Coefficient for Improved Channels

Channel Cover	"*n*" Value
Bare Soil	0.025
Grass-Lined	0.040
Rip-Rap Lined	0.070
Concrete Lined	0.013

10.5.4 CHANNEL EROSION CONTROL

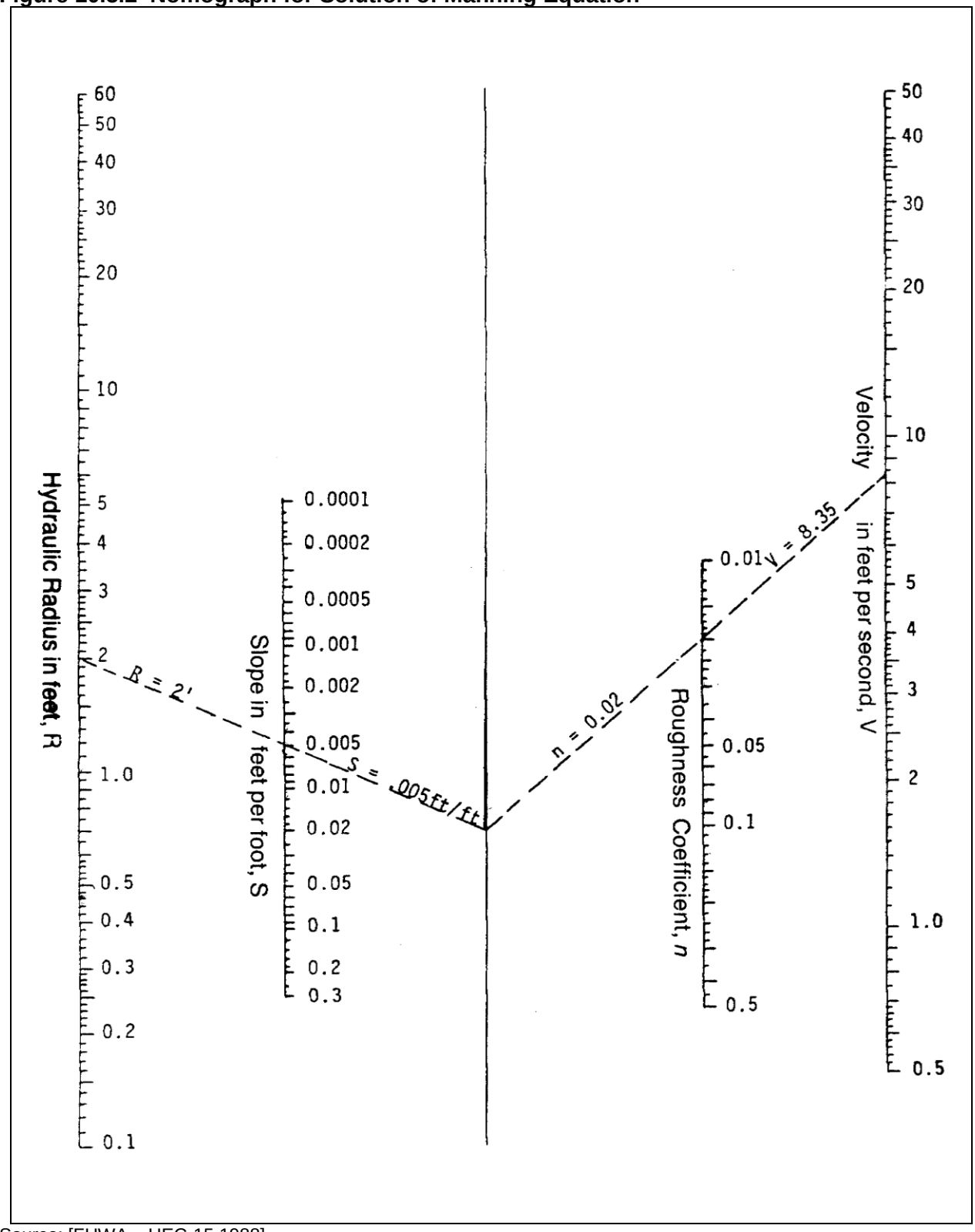
Erosion protection is necessary to ensure that channels maintain their capacity and stability and to avoid excessive transport and deposition of eroded material.

All erosion and sediment control measures shall be designed in accordance with the North Carolina Sedimentation Pollution Control Act of 1973. The Designer is to reference the *Erosion and Sediment Control Planning and Design Manual,* [NCDEQ, latest edition]. This manual contains valuable information and tools for developing plans to minimize soil erosion and prevent sedimentation pollution associated with land-disturbing activities.

10.5.5 OPEN CHANNEL DESIGN AIDS

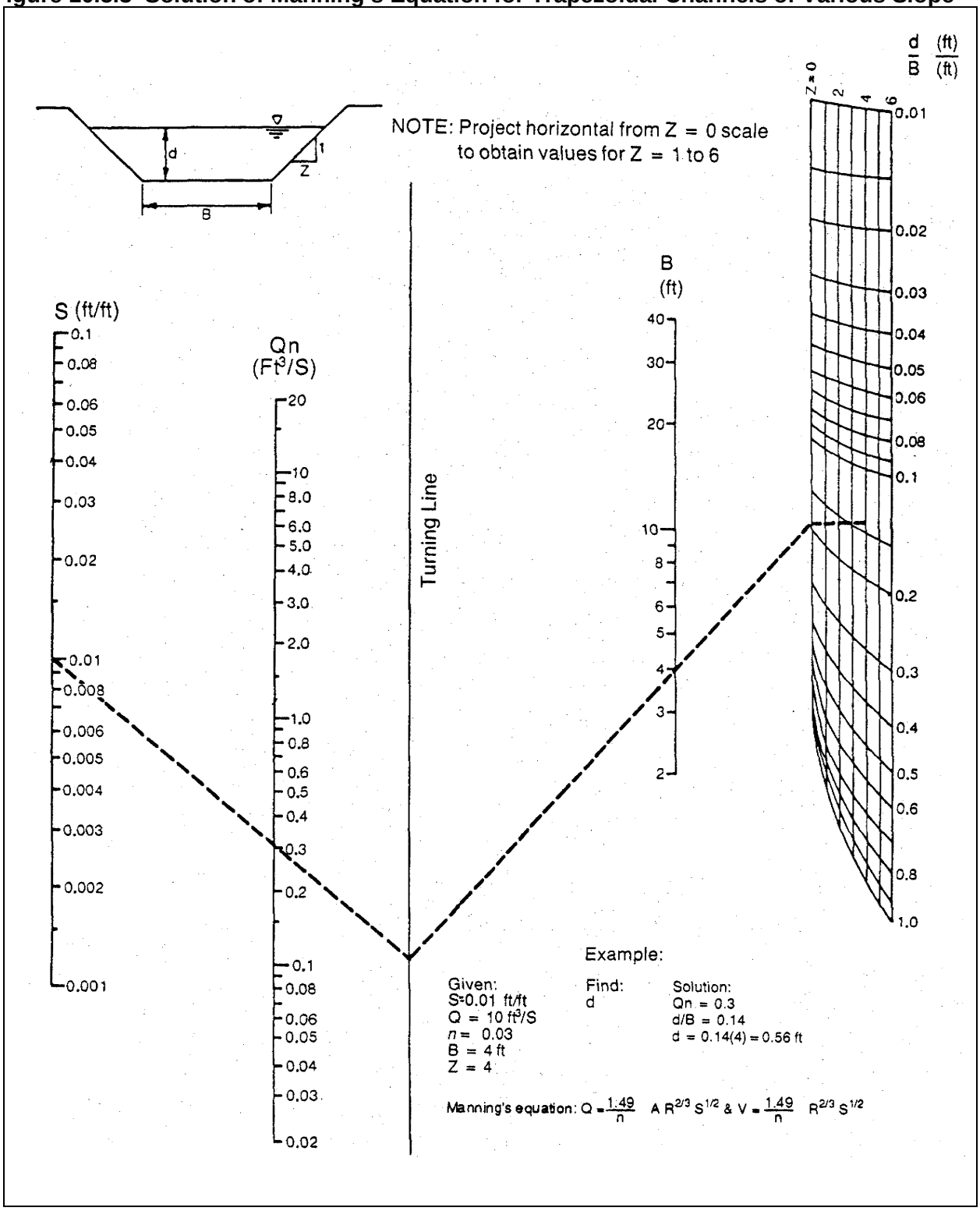
Figures 10.5.2 to 10.5.7 provide assistance to the designer of open channels.

Figure 10.5.2 Nomograph for Solution of Manning Equation



Source: [FHWA – HEC-15,1988]

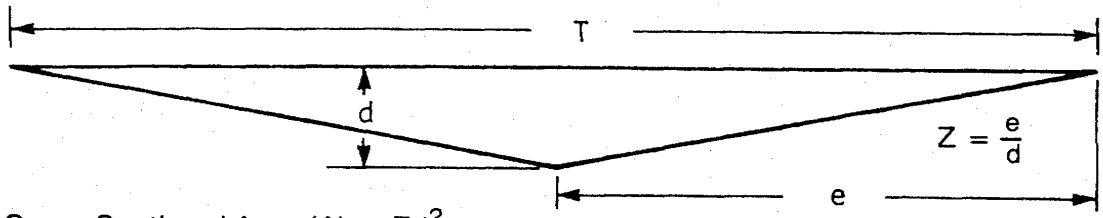
Figure 10.5.3 Solution of Manning's Equation for Trapezoidal Channels of Various Slope



Source: [FHWA – HEC-15, 1988]

Figure 10.5.4 Channel Geometries for V-Shape, Parabolic and Trapezoidal Channels

V-Shape

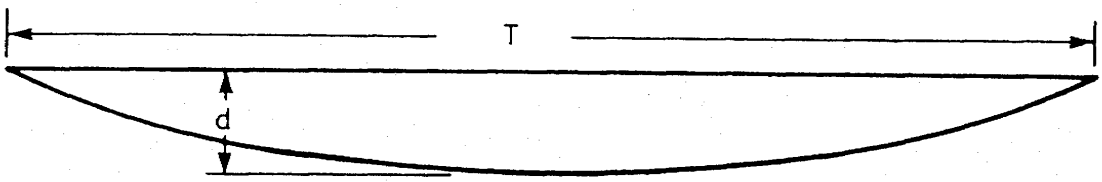


Cross-Sectional Area (A) = Zd^2

Top Width (T) = $2dZ$

Hydraulic Radius (R) = $\frac{Zd}{2\sqrt{Z^2 + 1}}$

Parabolic Shape

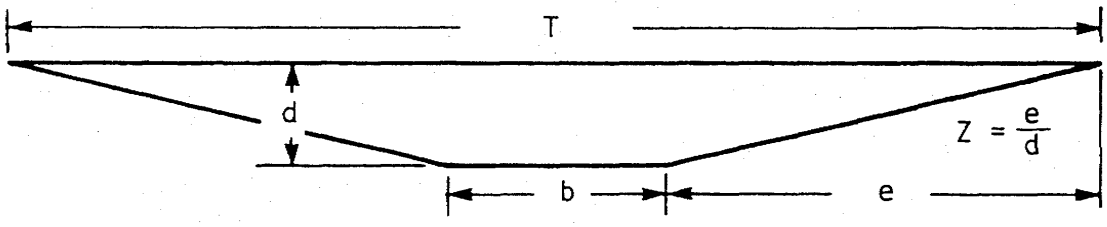


Cross-Sectional Area (A) = $\frac{2}{3}$ Td

Top Width (T) = $\frac{1.5\ A}{d}$

Hydraulic Radius = $\frac{T^2 d}{1.5T^2 + 4d^2}$

Trapezoidal Shape



Cross-Sectional Area (A) = $bd + Zd^2$

Top Width (T) = $b + 2dZ$

Hydraulic Radius = $\frac{bd + Zd^2}{b + 2d\sqrt{Z^2 + 1}}$

Source: ["E&S Control Planning and Design Manual," DEHNR, May 1994 Revised]

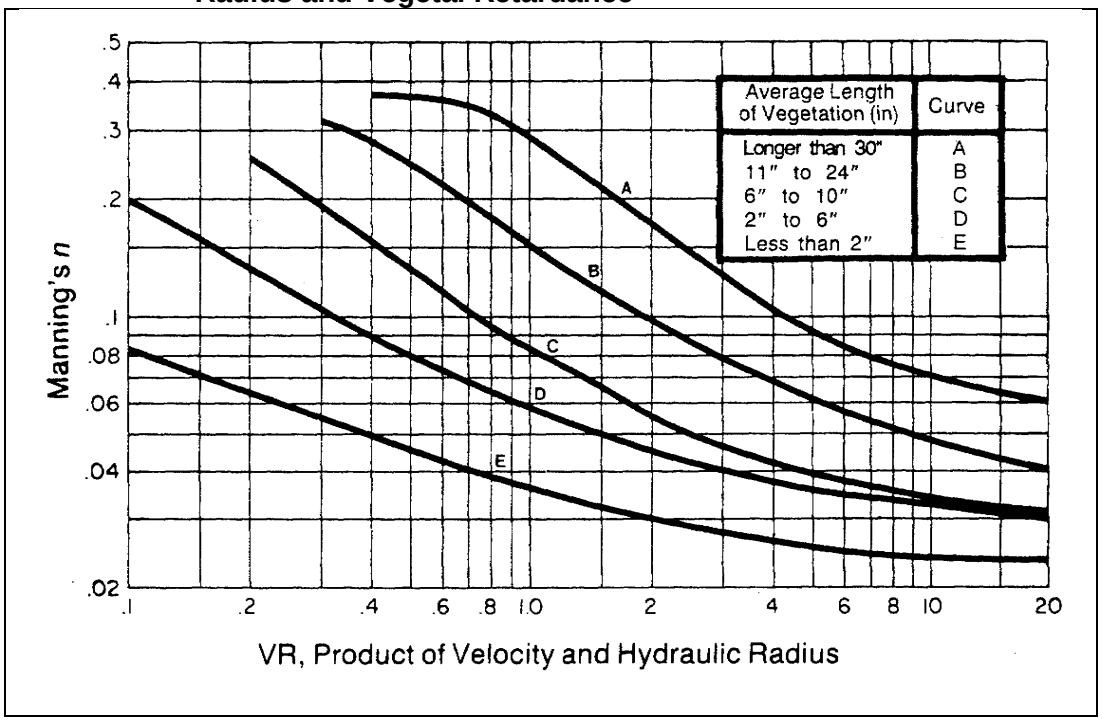
Figure 10.5.5 Maximum Allowable Design Velocities[1] for Vegetated Channels

Typical Channel Slope Application	Soil Characteristics[2]	Grass Lining	Permissible Velocity[3] for Established Grass Lining (ft/sec)
0-5%	Easily Erodible Non-Plastic (Sands & Silts)	Bermuda grass	5.0
		Tall Fescue	4.5
		Bahia grass	4.5
		Kentucky bluegrass	4.5
		Grass-legume mixture	3.5
	Erosion Resistant Plastic (Clay Mixes)	Bermuda grass	6.0
		Tall Fescue	5.5
		Bahia grass	5.5
		Kentucky bluegrass	5.5
		Grass-legume mixture	4.5
5-10%	Easily Erodible Non-Plastic (Sands & Silts)	Bermuda grass	4.5
		Tall Fescue	4.0
		Bahia grass	4.0
		Kentucky bluegrass	4.0
		Grass-legume mixture	3.0
	Erosion Resistant Plastic (Clay Mixes)	Bermuda grass	5.5
		Tall Fescue	5.0
		Bahia grass	5.0
		Kentucky bluegrass	5.0
		Grass-legume mixture	3.5
>10%	Easily Erodible Non-Plastic (Sands & Silts)	Bermuda grass	3.5
		Tall Fescue	2.5
		Bahia grass	2.5
		Kentucky bluegrass	2.5
	Erosion Resistant Plastic (Clay Mixes)	Bermuda grass	4.5
		Tall Fescue	3.5
		Bahia grass	3.5
		Kentucky bluegrass	3.5

Source: USDA-SCS Modified

NOTE: [1] Permissible Velocity based on 10-yr storm peak runoff.
[2] Soil erodibility based on resistance to soil movement from concentrated flowing water.
[3] Before grass is established, permissible velocity is determined by the type of temporary liner used.

Figure 10.5.6 Manning's *n* Related to Velocity, Hydraulic Radius and Vegetal Retardance



Source: [E&S Control Planning and Design Manual," DEHNR, May 1994 Revised]

Figure 10.5.7 Retardance Classification for Vegetal Covers

Retardance	Cover	Condition
A	Reed canary grass	Excellent stand, tall (average 36”)
	Weeping love grass	Excellent stand, tall (average 30”)
B	Tall fescue	Good stand, uncut (average 18”)
	Bermuda grass	Good stand, tall (average 12”)
	Grass-legume mixture (tall fescue, red fescue, sericea lespedeza)	Good stand, uncut
	Grass mixture (timothy, smooth brome grass, or orchard grass)	Good stand, uncut (average 20”)
	Sericea lespedeza	Good stand, not woody, tall (average 19”)
	Reed canary grass	Good stand, cut (average, 12-15”)
	Alfalfa	Good stand, uncut (average 11”)
C	Tall fescue	Good stand (8-12”)
	Bermuda grass	Good stand, cut (average 6”)
	Bahia grass	Good stand, uncut (6-8”)
	Grass-legume mixture- Summer (orchard grass, redtop, and annual lespedeza)	Good stand, uncut (6-8”)
	Centipede grass	Very dense cover (average 6”)
	Kentucky bluegrass	Good stand, headed (6-12”)
	Redtop	Good stand, uncut (15-20”)
D	Tall fescue	Good stand, cut (3-4”)
	Bermuda grass	Good stand, cut (2.5”)
	Bahia grass	Good stand, cut (3-4”)
	Grass-legume mixture- Fall-spring (orchard grass, redtop, and annual lespedeza)	Good stand, uncut (4-5”)
	Red fescue	Good stand, uncut (12-18”)
	Centipede grass	Good stand, cut (3-4”)
	Kentucky bluegrass	Good stand, cut (3-4”)
E	Bermuda grass	Good stand, cut (1.5”)
	Bermuda grass	Burned stubble

Modified from: USDA-SCS, 1969. Engineering Field Manual.

Section 11 – REFERENCES

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11.3 FHWA, Hydraulic Engineering Circular No. 22, *Urban Drainage Design Manual, revised August 2013 or* latest edition.

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11.28 *Urban Storm Drainage Criteria Manual*, 1969.

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WATER & SEWER DESIGN

(Last revised 9/12/24)

SELECTED LINKS TO SECTIONS WITHIN THIS DOCUMENT

Part 1 – General
Part 2 – Water Distribution
Part 3 – Gravity Sewer
Air Release Valve - Water
Bury - Water
Computing Fire Demand
Cross Connection Prevention
Dead Ends/Blow Offs
Easements - Sewer
Fire Hydrants
PavementReflectorFire Hydrant Flow Requirements
Materials - Force Mains
Materials - Sewer Pipe
Materials - Water Pipe
Manholes
Manholes - Drop Across Invert
Manholes - Drop
Manhole Connections
Manhole Corrosion Protection
MH's - Watertightness/Flooding
Pump Stations - Sewer
Services - Water
Services - Sewer
Sewer Aerial Crossings
Sewer - Bury/Slope
Sewers in Fine Grained Soils
Sewer - Size/Mat'ls Change
Sewers at Streams
Sewer/Well Conflicts
Swimming Pools, Draining
Valving - Water
Warning Tape, Metallic

USEFUL REFERENCES

Cross-Connection/Backflow Protection (Town Code, Title V: Public Works, Chapter 53)
Unified Development Code (Town Code, Title XV: Land Usage, Chapter 155)

1.1 GENERAL

1.1.1 SPECIFICATION AND DESIGN MANUAL:

A. All projects within the jurisdiction of the Town of Clayton shall be designed and constructed in accordance with the Town of Clayton's Manual of Specifications and Standards, latest revision.

B. **Public sanitary sewer gravity mains, force mains, and lift stations** shall conform to the design and construction requirements of the NC Department of Environmental Quality (NCDEQ) NCAC Title 15A 02T, *Waste not Discharged to Surface Waters*, latest revision.

C. **Public water distribution systems** shall conform to the design and construction requirements of the NCDEQ, NCAC Title 15A, Subchapter 18C, Water Supplies, and the *Rules Governing Public Water Systems*, latest revisions.

D. **Gravity Sewers Minimum Design Criteria** shall conform to the requirements of NCDEQ's *Minimum Design Criteria for the permitting of Gravity Sewers*, latest revision.

E. **Pump Station and Force Main Design** shall conform to the requirements of NCDEQ's *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains*, latest revision.

F. Prior to commencing construction, all plan approvals and water and/or sewer permits shall be obtained.

1.1.2 PERMITS:

A. **Encroachment Permits:** An encroachment agreement will be required from any Contractor or Developer wishing to excavate or place utilities within DOT or Town of Clayton's right-of-way.

B. **Swimming Pools, Draining**: Swimming pool filter backwashing involves a small amount of water in both private and public swimming pools. As such, unless a pool is located in WS or SA classified waters, pool backwash may be surface discharged. Discharge of filter backwash into the Town of Clayton sanitary sewer system is prohibited. NCDEQ deems discharges from filter backwash and draining associated with swimming pools to be permitted as along as water quality standards (associated with WS or SA waters) are not contravened or expected to be contravened. (Ref: 15A NCAC 02H .0106 *Filing Applications*, paragraph f). The Town of Clayton requires that both chlorine and salt be removed prior to discharge to surface waters.

C. **Pavement Cuts**: Pavement cuts in streets shall be repaired in accordance with the specific requirements of public agency on whose street or roadway the utility is being placed, as well as any other applicable requirements dictated in the approved encroachment permit. Open cut or bored crossings shall otherwise adhere, as applicable, to specification 02275, *Trenching, Backfilling & Compaction of Utilities*.

D. Developer must obtain all other State and Local permits, as applicable (401/404, Air Quality, Erosion and Sedimentation Control, Zoning, etc.).

E. **Water & Sewer Permits**: All applicable water and/or sewer permits required by NCDEQ shall be issued prior to approval of Construction Documents. The developer's design professional shall be responsible for all documentation necessary for issuance of the permits, and close-out upon completion of the project. The Engineering Director shall require that a preconstruction conference be held prior to commencing construction.

Plan Review and Observation Fees: Refer to the Comprehensive List of Fees & Charges as adopted annually by the Town Council for applicable fees. All plan review and construction inspection fees must be paid prior to approval of construction documents. Fees are subject to change. If fees increase during the application process the application is subject to the new/changed fees.

1.2 WATER SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for water system design on systems owned and maintained by the Town of Clayton.

1.2.1 DISTRIBUTION SYSTEM

A. **General:** Distribution systems shall generally meet the minimum requirements of the NCDEQ, NCAC Title 15A, Subchapter 18C, Water Supplies, latest revision.

1. **Water Supply System**: The developer shall connect the subdivision or development with the water system at their expense and shall design and construct it in such a manner as to adequately provide and serve the development with water for both domestic use and fire protection.

   The Engineering Director's staff reserves the right to determine criteria for each potable water system based upon conditions that may exist for that particular location, anticipated level of development, planned use, providing for future connections, or other criteria. In general, however, potable water pipelines and appurtenance shall be sized to handle the highest demand on the system within the sphere of influence.

2. No new permanent structures, landscape plantings (e.g., trees and large shrubs), monuments, ornamental signage, fences or ponds shall not be constructed over water mains or located within public water or sewer easements.

3. Consider not allowing residential lots to be platted on easements

B. **Fire Demand:** For design purposes, refer to the NC State Building Code: Fire Prevention Code, latest revision (https://codes.iccsafe.org/content/NCFC2018)

C. **Design - System Design:** As part of the design and Construction Document Approval process, a Professional Engineer Registered in the State of North Carolina shall model all new systems using **EPAnet, , WaterCAD**, or other approved software compatible, with the Town's Water System Model. A design report certified by the Engineer shall be submitted for review by the Town and include, at a minimum:

   a. A plan-view layout of the system
   b. Assumed minor losses,
   c. Pipe roughness ("C" Constants assumed),
   d. Line lengths,
   e. Fixed grade node elevations,
   f. Node ID numbers,
   g. Demand at each node
   h. Pipe ID numbers,

i. Fire flow testing shall be done for each project by Design Engineer. Contact the Town of Clayton Engineering Department to schedule fire flow testing.
j. Include a calculation of static pressure converted to elevation head for verification of starting elevation head, the static water elevation in tank at the time a static pressure reading was taken and, ground elevation of hydrant tested.

1. **Pipeline Velocity**: 3- to 6-fps normal working conditions are preferred although higher velocities in short lengths of pipe may be tolerated for brief periods. Sustained high discharge velocities can scour the pipe's interior and increase leakage.

2. **Main Size:** Water mains shall be sized in accordance with the Town of Clayton's long-range water distribution system plans. In general, the Town's pressure zones are designed to maintain a static pressure of 50- to 100-psi. Maximum static water pressure allowed for any service in new development shall not exceed 100-psi.

   a. Standard main sizes in the Town of Clayton's distribution system are 6, 8, 10, 12, 16, 20, 24, and 30 inches. The minimum diameter of public water main is 6 inches and should only be allowed in cul-de-sacs, internal/loop streets within subdivisions, and other areas where water mains will not be extended in the future, if it is sufficient to meet the development's water demand requirements (including fire flows).

   b. Fire hydrants shall not be installed on mains less than 6 inches in diameter.

3. **Looping/Interconnectivity**: Water mains shall be designed to be looped and interconnected wherever feasible and as required by Engineering Director at the expense of the developer.

4. **Valving**: Valve shall be fully accessible from ground surface by means of a valve box.

   a. **Gate Valve & Tapping Valve type/size**:

      i. **Valves on 6- through 12-inch mains**: 6- through 12-inch valves shall be resilient seat NRS wedge gate valves.

      ii. **Valves on 16-inch and larger mains**: Either resilient seat wedge NRS gate valves or butterfly valves are permitted on 16-inch and larger water mains. Butterfly valves are preferred.

   b. Valves shall be installed at all branches from feeder mains and between mains and hydrants according to the following schedule to allow for total isolation:

      i. 3 valves at tees (including fire hydrant tees),

      ii. 4 valves at crosses,

iii. Where spacing of valves as required per 1 and 2 above exceeds the following distances, an in-line valve shall be installed on the water line:

Line size	Distance
6 thru 10-inch mains	450 feet
12-inch mains & Larger	1000 feet

If required, when tapping an existing live main and inserting a main line valve, the main being tapped must be shut off and a valve installed (cut-in) on the existing main within close proximity to the new connection. In lieu of shutting off the existing main and cutting in a valve, the Engineering Director may, by alternative standard request, allow an "inserting" valve to be placed if the former is undesirable or impractical.

c. **Valve Size to Match Main Size**: The valve size must match the line size.

d. **Downsizing Mains**: When downsizing a main, locate a valve after the reducer on the side with the smaller diameter. However, the designer must evaluate thrust forces and accommodate the forces by placement of a thrust collar (if required) on the larger main. Provide Calculations for review.

e. **Manhole Valves**: Unless approved otherwise by the Engineering Director, valves 16 inches and larger may be placed in a minimum 6-foot diameter precast concrete doghouse manhole. The operating nut must be positioned under the manhole opening. See **Standard Detail 513.09**.

D. **Piping Material Applications**

1. **General**: Use pipe, fittings, and methods of joining in accordance with the following:

MATERIAL	WATER MAINS	WATER SERVICES	BACKFLOW PREVENTION BOXES/VAULTS
UNDERGROUND APPLICATIONS			
Ductile Iron	6-inch through 30-inch	3-inch and larger	3-inch through 30-inch
PVC C-900, DR 14 (Class 305)	6-inch through 12-inch	Not allowed	Not allowed
HDPE Pipe – Directionally Bored	6-inch through 12-inch	Not allowed	Not allowed
Type K Soft Copper	Not allowed	3/4" through 2-inch	Not allowed

MATERIAL	WATER MAINS	WATER SERVICES	BACKFLOW PREVENTION BOXES/VAULTS
UNDERGROUND APPLICATIONS			
Brass Pipe	Not allowed	Short sections of 2-inch	3/4-inch through 2-inch
ABOVE GROUND APPLICATIONS			
Ductile Iron	6-inch through 30-inch	Not allowed	6-inch through 30-inch
Brass Pipe	Not Allowed	Not Allowed	3/4-inch through 2-inch

2. **Metallic Warning Tape**: 3-inch **wide** blue warning tape marked "Caution Water Main Below" shall be installed in the trench excavation over all water mains prior to backfill. See **Standard Detail 511.01**.

3. **RFiD Marker Balls**: A 4-inch diameter self-leveling programmable, water-tight polyethylene, passive location marker, shall be placed above applicable pipe as shown on **Standard Detail C01.04**.

E. **Joint applications**

PIPE	JOINT TYPE	COMMENT
UNDERGROUND APPLICATIONS		
Ductile Iron Pipe	Push On	6-inch through 30-inch
Ductile Iron Fittings	Mechanical Joint	6-inch through 30-inch
PVC C900/C905	Push On	6-inch through 12-inch
Type K Soft Copper water service	Compression type brass fittings	3/4-inch through 2-inch
HDPE water main, directionally bored	Fusible Butt Joints	6-inch through 12-inch
Brass Pipe	NPT threaded	Short sections of ¾-inch through 2-inch
Stainless Steel	NPT threaded	Short sections of ¾-inch through 2-inch
ABOVE GROUND APPLICATIONS		
Ductile Iron	Flange Joint	3-inch through 30-inch
Brass	NPT threaded	3/4" through 2-inch
Stainless Steel	NPT threaded	3/4" through 2-inch

1. Galvanized pipe and galvanized fittings are not permitted in the Town of Clayton water system.

2. PVC glued or threaded pipe or fittings are not permitted in the Town of Clayton water system.

3. Provide transition couplings and special fittings with pressure equal to or exceeding the pressure rating of the pipe or fitting to which they will be either connected or fitted.

4. Do not use flanges, unions, or keyed couplings for new underground piping. With the approval of the Engineering Director, they may; however, be used in above ground applications such as vaults. 3-part unions may be used for repairs.

F. **Location**: Water mains shall be located within dedicated street rights-of-way or publicly dedicated easements.

G. **Fire Hydrants:**

1. All public hydrants are to be located in a street right-of-way or Town of Clayton public utility easement providing a minimum of 5-feet on all sides. See **Standard Details 514.04** and **514.05** for hydrant location in relation to street:

2. **Hydrant Location**: A hydrant shall be located at every street intersection, and; unless shown otherwise below, hydrants shall be located in accordance with Appendix C, *Fire Hydrant Locations and Distribution* of the NC Fire Prevention Code and are subject to review and approval by the Engineering Director and the Fire Marshall.

3. **Maximum Distances from Structures**:

   i. **Residential**: 500 feet by the pull of the hose method (not as the crow flies).

   ii. **Commercial**: 300 feet by the pull of the hose method.

4. **Minimum distances from a structure**: No new hydrant shall be located closer than 40 feet from a non-residential structure.

5. **Minimum Fire Flow at Hydrants**: The minimum design fire flow for residential subdivisions shall be 1,000 gpm with 20-psi residual flow. Each phase shall be required to meet this requirement. For non-residential subdivisions (commercial, multi-family, etc.), the minimum flow shall be no less than 1,500 gpm; however, the NC Fire Prevention Code, as updated from time to time, shall be utilized in determining the estimated water needs for fire protection.

6. **Services on Fire Hydrant Branches:** Services on dedicated fire hydrant branches are not permitted.

H. **Pressure**:

1. **Minimum System Pressure:** Water distribution mains shall be sized to provide a minimum pressure at all points within the distribution system of not less than 20 psi (gauge) during periods of peak demand (fire flow) combined with maximum day demand. System extensions not specifically designed for fire flows shall have the capacity to maintain a pressure of at least 30 psi (gauge) throughout the system during periods of peak flow.

a. Minimum water pressure requirements shall be considered at the ground elevation at the point of service connection, or at the building pad elevation if it is greater than the elevation of the service connection point.

2. **Pressure Reducing Valves**: When the maximum static pressure in a new or improved/upgraded system exceeds 80 psi, businesses and/or residences shall be equipped with a pressure-reducing valve at the developer/owner's expense. The valve shall be located on private service lines. The NC State Plumbing Code covers the installation of pressure reducing valves. The pressure reducing valves are neither owned by nor maintained by the Town of Clayton.

I. **Bury**:

1. Water mains 6 inches or less in diameter shall be designed with a minimum bury of 36 inches of cover below finished grade. Mains 8 inches and larger shall be designed with a minimum bury of 42 inches of cover below finished grade. Water mains shall be designed with a maximum of 72 inches of cover, as measured from the top of crown to the finished grade, or as required by the pipe manufacturer unless approved otherwise by the Engineering Director. See **Standard Detail 511.01**.

2. Under conditions which otherwise prevent 36 inch bury, such as at crossings above shallow buried structures or rock, the pipe shall be Ductile Iron and the minimum cover shall be 30 inches, as approved by the Engineering Director.

3. Lines which have less than 30 inches of cover at ditch or culvert crossings shall be Ductile Iron and encased in concrete. The casing shall extend through all areas until the depth of cover above the DIP is greater than 30 inches. However, the encasement may be no less than 5 feet beyond each side of the ditch, stream, or culvert. Such encasements shall require approval of the Engineering Director. See **Standard Details C07.01** and **C07.02**

J. **Horizontal and Vertical Blocking**: Concrete thrust blocking, tie rods, restrained joint pipe, and/or other means of restraint shall be provided at all changes in pipe direction. Concrete thrust blocking is not recommended where the blocking may bear on other utilities or where the area behind the block may be excavated in the future. Calculations shall be provided by a Professional Engineer licensed in the State of North Carolina.

K. **Dead end lines:** A fire hydrant or other means of purging dead end lines is required. Temporary Blowoff assemblies, in lieu of fire hydrants (only as directed by the Engineering Director), shall be installed at the end of all water mains and at other locations as required for flushing. No permenant blowoff assemblies are allowed. The following blowoff sizes shall apply for the applicable main size:

Main Line Size	Blowoff Size Required	Blowoff Valve Size	Standard Detail Reference
Temporary Blowoff Assemblies			
Mains up to 8 inches	2-inch	Valve to match main size[a]	**514.01**

[a]A temporary blowoff shall have a full 18-foot joint of mechanical joint pipe between the valve (main line size gate valve), and the standpipe. The 18-foot joint of pipe shall include a thrust collar.

The maximum length of a permanent dead end 6 and 8-inch main shall be 400 feet and 700 feet; respectively, unless approved by the Engineering Director. A fire hydrant is required at the dead end.

L. **Sag Vertical Blowoffs**: When directed by the Engineering Director, provide a fire hydrant (see **Standard Details 514.04** and **514.05**) when lines have severe sag where sediment can accumulate and retard flow in water line (such as when running beneath large streams, ditches or culverts).

M. **Crest Vertical – Air Release Valves**: Where water mains are subject to air entrapment, provide an air release valve constructed in accordance with **Standard Detail 516.01,** as applicable, located at the highest elevation on the main. Where the main undulates along its length and several crests are encountered, a separate air release manhole will be required at each crest. The Engineering Director, before placement, shall approve the final actual location of all air release manholes. Typically, when the relative elevation difference in a water main (from the main's sag elevation to the crest elevation) is greater than 25 feet, an air release valve will be needed, unless otherwise directed by the Engineering Director.

A minimum 2-inch air release valve shall be used on water mains 6 inches and larger in diameter. Refer to air release valve manufacturer's recommendations for air release sizing and quantity.

The valve shall be used to bleed air from the line as it is filled with water for testing.

Manhole Size Determination:
a. The minimum diameter of manholes shall be 5 feet.
b. Manholes with 16-inch diameter or larger pipe shall be a minimum of 6 feet in diameter.

N. **Vertical upward thrust**: Vertical upward thrust at fittings or vertically deflected joints shall be resisted with thrust collars of adequate size and weight, pilings, or other acceptable methods approved by the Engineering Director. As an alternate, swivel connectors may be used on 6-inch mains. See **Standard Detail 512.04**. Calculations shall be provided by a Professional Engineer licensed in the State of North Carolina.

O. **Relation of Water Mains to Sewers:**

See specification 02510 – Water Distribution, Part 1 - General, paragraph 1.9 *Project Conditions* for separation requirements between water mains and sewer mains/structures and between water mains and other utilities/structures. See also **Standard Detail C01.05**.

P. **Stream crossing**:

Where possible, all stream crossings shall be made below water level. Stream crossings shall be made as close to a 90-degree angle as possible. All stream crossings shall be made with restrained joint ductile iron pipe. Valves may be required on each side of the crossing and restrained by anchor blocks. All stream crossings shall require steel casing. Valves shall be a minimum of 20 feet from end of casing if valves are in line with casing. See **Standard Detail C07.02** for typical stream crossing detail and **Standard Detail C07.01** for casing requirements.

Below streambed crossing: Unless otherwise permitted by the Engineering Director, streambed crossings shall be made with no less than 24 inches of cover, 30 inches of cover if a water line, and 5 feet of cover if the stream/water course is wider than 15 feet at normal water level. See **Standard Detail C07.02**.

Above stream crossing: Water mains crossing streams above normal water level shall be placed above the 25-year, 24-hour storm elevation when practical and otherwise meet DEQ requirements for stream crossings. Stream crossings above water level shall be constructed with piers or other suitable methods approved by the Engineering Director.

Hanger Support from Bridges: In the design of an aerial system, provide both details and calculations showing the hanger type hanger capacity, hanger-to-bridge attachment type (mechanical or chemical), and capacity with a minimum safety factor of 3. Assume the pipe to be full. Provide lateral bracing of hanger to a girder or to bottom of bridge deck. Two pipe hangers per pipe joint shall be required. Provide plans showing the plan view and elevation of the water line crossing. Use of bridge hangers is subject to approval by the bridge owner.

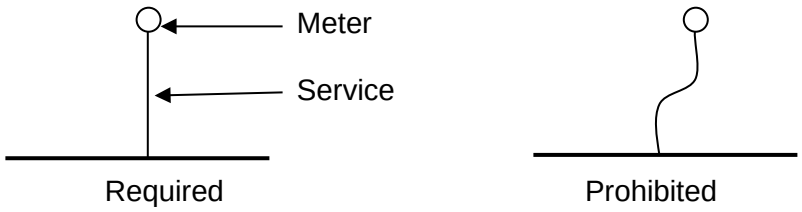
Thermal Protection, allowance for main expansion: Where aerial crossings are approved by the Town, install expansion devices as necessary to allow for expansion and contraction movement in pipe, such as at creek crossings. Expansion joints are typically to be provided where the line transitions from aerial to underground. Provide calculations showing expected differential movement. To prevent freezing, provide either pipe insulation jackets that totally cover the pipe (so that the pipe and insulation is placed inside the hanger assembly) or an insulation system that covers both the pipe and hanger assembly.

Q. **Taps**: Taps shall be made in accordance with the following table:

Service Size	Type Tap Allowed	Standard Detail Reference	Comments
¾-inch, 1-inch	Double Strap Bronze saddle	**513.04**	None
2-inch	Double strap bronze saddle	**519.03**	None
3-inch	Not allowed	-	3-inch water meters shall be served by a 4-inch tap with 4-inch service lines.
4-inch and larger	All stainless steel tapping sleeve & valve or a fitting	**513.02**	None

R. **Water Services**

General: A water service shall be or each lot abutting a public right-of-way. The service shall not be installed in a in driveway. The back of the meter box shall be located at the right-of-way and no closer than 1 foot from the back of the sidewalk, (see **Standard Detail 519.01**). Services shall be placed perpendicular to the main and shall not meander or snake in such a manner as to offset the meter from its main connection point (see schematic below). The meter box shall be set flush with the finished grade and shall not be installed in a ditch slope. In situations where the meter box is located outside of the public right-of-way, a water easement shall be provided/dedicated to the Town. A minimum 5' easement shall be located on all sides of the meter box, measured from the centerline of the meter box.



If any water or sewer service is to be moved after the initial install, the Town must be notified in advance for inspection.

For multi-family housing, residential or commercial condominiums, and attached units within a development that can be sold individually, individual water meters are required unless a variance is requested of, and approved by, the Engineering Director and master metered. In the event a development is approved for a master meter, only one sewer connection will be allowed.

Service Location Relative to Sewer Service: The water service shall be located within 3 feet of the sewer service.

S. **Large Meter Vaults, Above Ground Assemblies, and Building Meter Rooms** shall be designed and constructed to provide minimum clearances between the pipe, fittings or vault/enclosure/building meter room walls per the dimensions

prescribed in the applicable vault detail(s). See **Standard Details 519.04, 519.05, 519.06, 519.07, 519.08, 519.09, 519.10**, and **519.11.** *See the applicable detail for the particular type application proposed.*

T. **Multiple Feeds**

Water systems with multiple feeds require the installation of double check valve assemblies on the downstream side of each meter, unless the use of the facility requires a RPZ in accordance with the Town of Clayton's *Water System Cross-Connection Control Ordinance*, latest revision.

U. **Cross-connection prevention**

Approved backflow prevention assemblies shall be installed on the service line to all non-residential and irrigation facilities. All backflow units shall be installed between the Town's system and the first branch or tap. See **Standard Details 519.06, 519.07, 519.08, 519.09, 519.10**, and **519.11**, as applicable. See also the Town of Clayton's *Water System Cross-Connection Control Ordinance*, latest revision for hazard classification and type backflow device requirements.

V. **Testing:**

General: The Town of Clayton will provide water for testing purposes on water mains. Refer to technical specification 02510 – *Water Distribution*, paragraph 3.4 – *Testing and Disinfection* for required testing requirements and methods. Testing of completed water mains shall include the following:

1. Hydrostatic Testing

2. Chlorination and Bacteriological Tests

Final approval/acceptance by the Town and NCDEQ must be completed within 90 days of testing or all testing will need to be re-done. Re-inspection fees may apply.

1.3 GRAVITY COLLECTION SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for sewer system design on systems owned and maintained by the Town of Clayton.

1.3.1 GENERAL

A. **General:** Gravity Collection systems shall generally meet the minimum requirements of the State of North Carolina Department of Environmental Quality (NCDEQ), NCAC Title 15A 02T *Waste Not Discharged to Surface Waters* , latest revision.

1.3.2 DEFINITIONS

A. **Definitions:** For the purposes of this design manual, the following definitions refer to sanitary sewer collection systems that come under the authority of the Town of Clayton as specified within this section and other sections of this manual.

1. **Main or Trunk Sanitary Sewer**: Exterior gravity sanitary sewer systems receiving flow from one or more laterals or mains.

2. **Sewer Service**: Exterior domestic sewer piping serving a private residence, business, commercial facility, or industrial user. This line, in its entirety, belongs to the customer/user for operation and maintenance.

3. **Interceptor:** Sewer that receives flow from a number of gravity mains or trunk sewers, usually placed along a stream or river.

B. The following are industry abbreviation for various pipe materials:

1. **DIP**: Ductile Iron Pipe

2. **HDPE**: High Density Polyethylene Pipe

3. **PVC**: Polyvinyl Chloride Plastic

1.3.3 COLLECTION SYSTEM DESIGN

A. **Minimum Size/Sizing:** No public gravity sewer conveying wastewater shall be less than 8 inches in diameter. No private gravity sewer service in the public right-of-way conveying wastewater shall be less than 4 inches in diameter.

B. **Developments**: Wastewater flows for developments with localized sewers shall be determined in accordance with NCAC Title 15A 02T .0300 *Sewer Extensions*.

Approval of Wastewater Allocation required prior to Construction Document submittal.

C. **System Design**:

1. The system is to be designed taking into account the total natural drainage basin, land use, ultimate population estimates, maximum anticipated commercial and industrial contribution, infiltration and a 50-year design period. The capability of the downstream sewers to accept the future flow tributary to the collections system shall be evaluated by the design engineer. Sewer size shall be based on an average daily flow of 250 gpd per single-family dwelling unit and 120 gpd/bedroom (minimum of 240 GPD) for all other residential facilities and a peak/average ratio of 2.5. The ratio includes an allowance for infiltration but not inflow. The table below should be used as a general guide for determining equivalent average daily flow and the peak flow for various non-residential developments.

Non-Residential Uses			
Land Use	**Equivalent Persons/Acre**	**Average Flow (gal/acre/day)**	**Peak Flow (gal/acre/day)**
Shopping Center	18	1,800	4,500
Bus/Commercial	25	2,500	6,250
O&I	30	3,000	7,500
Industrial	50	5,000	12,500

[a]Table excerpted partially from the City of Raleigh Public Utilities Handbook

2. The Designer shall evaluate the capacity of the receiving sewer main both at and from the point of discharge to a point downstream identified by the Engineering Director in order to determine if the systems can handle the additional sewer flow.

D. **Design Flow Depth**: It is customary to design sanitary sewers with some reserve capacity. Generally, sanitary sewers through 15 inches in diameter are designed to flow half full. Larger sanitary sewers are designed to flow three-fourths full. These factors include infiltration but exclude inflow. If inflow is anticipated or known to exist in upstream sewers, the Engineering Director may require that the design flow be increased accordingly and the justification/computation/source referenced in the design calculations and provided to the Engineering Director for review.

E. **Main Depths**: The depth of sewer mains shall be great enough to serve adjoining property, allowing for sufficient grade on service lines. Main depth shall also take into consideration potential conflicts with parallel pipe systems (such as water mains and storm drainage lines), providing room for the service laterals to pass either over or below lines.

F. **Extensions to Adjacent Property**: Where tributary flow is expected from an upstream natural drainage basin or sanitary sewer service area, as approved by the Engineering Director, designers shall install extensions of sewer main to the farthest property line of tract and/or along the frontage of all abutting street

ROW/easements as necessary to provide a future sewer service to all adjacent properties in accordance with Clayton's UDO (chapter 155, latest revision).

G. **Acceptable Pipe Material**

1. Refer to **Part** 2 - PRODUCTS of 02530 – *Sanitary Sewer* for detailed specifications for pipe and fittings listed below. Use pipe, fittings, and joining methods according to the application indicated.

Allowable Materials for Gravity Sewer Pipe (up to 18 inches in diameter)	
Services	Sch 40 PVC, Class 350 DIP[A],
Gravity Mains	SDR 35 PVC, C-900 PVC (Class 150, DR18), C905 PVC (14-inch through 18-inch; Class 160, DR 18), Class 350 DIP[A]

Allowable Materials for Gravity Sewer Pipe (21 to 48 inches in diameter)	
Gravity Mains	Class 350 DIP [A]; C905 PVC (Class 160, DR 18), CCFRPM (ASTM D638)

Allowable Materials for Force Mains		
DIP	Class 350	
PVC	4-inch and larger	C900 PVC, Class 150, DR18 w/ Ductile Iron Fittings[A]
PVC	2-inch	ASTM D2241, SDR 21, Class 200
HDPE (Directional Bore Only)	4- through 8-inch	AWWA C906, PE4710 resin

[A]Protecto 401 Ceramic Epoxy Lined pipe and fittings

2. PVC sewer force mains are permitted under paved surfaces on a case by case basis as determined by the Engineering Director.

3. A-2000 PVC, Truss, HDPE, and VCP are not permitted for gravity pipe.

H. **Location:** All sewer mains shall be installed within the street right-of-way or within a dedicated Town of Clayton public utility easement. When located in street right-of-way, the sewer main shall be in the center of the pavement or right-of-way, as much as practical.

4. Minimum Plan Requirements:
   a. Manhole number and station.
   b. Manhole top and invert elevations
   c. Benchmark reference (elevations must be tied to mean sea level reference datum).
   d. Pipe grade and material, encasements, piers, crossing details, and access.
   e. Profile line drawing.

I. **Bury:** A minimum of 36 inches of cover shall be provided for all sewers. The Engineering Director must approve all installations of sewer lines with less than 36 inches of cover. See **Standard Detail 531.02**.

1. **Trench Loading Consideration**: When the allowable depth of bury has been exceeded, the designer shall show on the plans the beginning and ending stations where the pipe material, pipe class or bedding class changes are required. In the selection of the pipe material, pipe class and/or bedding class for the depth of bury required, the designer shall account for both the weight of the trench backfill and, in roadway applications, minimum H-20 live loads on pipe. Allowances for arching action of soil may be considered. Submit calculations to the Engineering Director to justify selection of pipe material, pipe class, or bedding shown on plans.

   Changes in pipe class or material shall occur only at manholes. Also, see paragraph L, Changes in Pipe Size or Material, below

J. **Slope:**

1. **General**: All sewers shall be designed and constructed to give mean self-cleansing velocities of not less than 2.0 feet per second, based on Manning's formula using an "n" value of 0.013 – this includes evaluating sewers flowing partly full. The following are the minimum slopes that shall be provided; however, slopes greater than these are recommended.

Minimum Slope	
Sewer Size (inches)	**Minimum Slope (%)**
8	0.40
10	0.28
12	0.22
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08

a. **Uniform slope between manholes**: Sewers shall be designed with uniform slope between manholes.

   Grade variation from required minimum slope: The line is to be inspected for conformance with line and grade shown on the plans. The Town of Clayton shall be provided with record drawing measurements (including actual distance between manholes and the as-built invert in and invert out elevations) on the As-Built Drawings.

   Vertical alignment:

   Maximum Slope: The maximum grade shall not exceed 10%.

Minimum Slope: No tolerance below the NCDEQ minimum slopes will be allowed. If the slope in the pipe is found to be less than acceptable the Contractor shall re-lay the pipe.

b. **Slope Increase:**

i. On upper reaches of small services and mains, due to water saving fixtures now employed, the designer should consider increasing the slope of gravity services above the minimum allowed in order to flush solids. Provide calculations confirming velocity.

ii. Special attention must be given to the early years that the new public system is used, as initial flows may be substantially lower than design flows and the velocities well below the minimum. The Engineering Director may direct usage of greater slope.

c. **Pipe size increase**: Sewers may not be upsized more than 1 OD pipe size to gain flatter slopes. If the minimum scouring velocity cannot be maintained during initial operation prior to the design flow capacities being reached, the developer may be required to periodically flush the system until volume has increased to affect a self-cleansing velocity. **Additional wastewater treatment fees may apply.**

d. **Steep Slope Protection**: Any time the grade is 9% or more, concrete collars shall be provided to prevent creep and/or to prevent water from flowing along the pipe and causing trench scour. Manholes shall be protected from corrosion generated by release of hydrogen sulfide gas from high turbulence associated with line velocity.

e. **High Velocity Protection**: Where design velocities are projected to be greater than 10 fps, the sewers and manholes shall be protected against internal erosion and impact by high velocity. Pipe shall conform to ASTM, AWWA, ANSI, etc., which provide protection against erosion. For velocities greater than 20 fps, erosion control measures shall be documented on the "Record Drawings" and the Engineer's Certification. See **Standard Detail 532.02**.

f. **Sewers placed in predominantly silty fine-grained soils**: The designer should consider placing either clay or concrete collars (dams) periodically along sewers constructed in and backfilled predominantly with silty soils – regardless of slope. Migration of fines from adjacent soil and loss of pipe support is possible. A non-woven separation geotextile fabric should be placed between the stone and the earthen backfill.

g. **Sewer main sections subject to excessive corrosion**: Where sewer mains, or sections of sewer mains, may be subject to excessive corrosion, the Engineering Director may require the use of polymer liners. In the case of large mains, the use of Centrifugally Cast, Fiberglass-Reinforced Polymer Mortar pipe (CCFRPM) may be required.

K. **Alignment:** All sewers shall have a straight alignment between manholes.

L. **Changes in Pipe Size or Material**:

1. **Pipe Size Changes**: Gravity sewer sizes shall remain constant between manholes. Pipe size changes shall occur only at manholes. When a smaller sewer joins a large one, the inverts of the sewers shall be arranged to maintain approximately the same energy gradient whenever possible by matching crown elevations of the pipes. Otherwise, no less than 0.8 times the pipe diameter of the two lines shall match.

2. **Undersized or substandard downstream sewers**: Sewer extensions shall be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole, with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. Justification shall be provided at the beginning of the project drawings indicating that the capacity of the downstream sewer will not be overloaded by the proposed upstream installation. The Town of Clayton reserves the right to prohibit additional flow into an undersized sewer for new growth.

3. **Pipe Material Changes**: To avoid couplings of dissimilar material, pipe material or pipe class must remain consistent between manholes and may not be changed. At manholes drops, the manhole drop material shall be C900 PVC and conform to **Standard Detail 532.09**.

M. **Uneven inverts of parallel pipelines in same trench**: Where more than one pipeline is laid in the same trench and the invert elevations are not identical, and where no concrete cradle or encasement is provided for the support of the high pipeline, its foundation shall be considered to be yielding. When bridging is required to support a portion of the pipeline over such yielding trench bottom, it shall not be considered to provide bridging strength. #57 stone shall be provided and used for this purpose.

N. **Buoyancy:** Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction and/or anchors where shallow cover and high groundwater or flooding conditions are anticipated. For design purposes, assume water to top of pipe and pipe is empty.

1. **Common Buoyancy Countermeasures**: Where countermeasures are deemed necessary to meet the minimum factors of safety noted in paragraph 1.3.7.C.2.c, Buoyancy Safety Factors, designers can consider countermeasures such as:

   a. Anti-flotation slabs,
   b. Concrete anti-flotation collars, or
   c. Increasing overburden depth.

O. **Connections to Existing Mains:** Connection to existing sewer mains shall be made at existing manholes or by the addition of a doghouse manhole.

P. **Service Connections**:

1. Services connected to gravity sewers shall be connected using in line wyes (**Standard Detail 533.01**) or saddles. In-line wyes shall be used for all service connections to new lines. Service saddles may be used on existing mains for fill-in lots or as a last resort. (see **Standard Details 533.01** and **533.02)**.

2. A cleanout will be installed on each house service. Unless topography requires otherwise, services are to be placed in the middle of the lot. The cleanout shall be located at the right of way or easement line. If the cleanout falls within concrete or asphalt, a cast iron valve box shall be installed over the cleanout (See **Standard Detail 533.01**, sheet 1). No sewer service is to be located in a driveway.

3. Minimum grade for 4-inch and 6-inch services shall be in accordance with the North Carolina State Plumbing Code, latest revision.

4. **Service connections to manholes**: Unless approved otherwise by the Engineering Director, services connections to manholes shall be made at dead end lines or whenever 6-inch services are used only. Service connections must enter the bottom of the manhole whenever possible. If not practical, services may be located above the bottom but may not enter the cone or its joint. Service connections in manholes shall also be core bored and booted and shall be separated by a minimum of 2 times the pipe OD (either vertically or horizontally) from other services or mains.

5. Vertical stacks or standpipe services are not allowed except as shown on **Standard Detail 533.01**, sheet 2 of 2.

6. **Services on Utility Easements**: All services going into a utility easement should be connected to the sewer line where practical. Cleanouts, typically located at the easement line, must project 3 feet above grade and be marked by a 4'-6" high fiberglass sewer post (**Standard Detail 539.01**) or a with a Utility Shroud Assembly per **Standard Detail 533.01**.

Q. **Public Easements:** Easements across lots, or centered on rear or side lot lines, shall be provided for utilities where necessary, and shall be at least 20 feet wide, which said easement may be a part of the vehicular access easements. Easements shall be graded generally flat with sufficient transverse grade to ensure cross drainage without surface ponding on easement. The width of easements (except when adjacent and parallel to right-of-way) shall be based on the following:

Sewer Lines	Min. Easement Width (feet)
Sewer Easements	**20***
Combinations Easements (Sewer with either Water or Storm Drainage)	**30***

*Width to be determined by the Engineering Director.

Consideration shall be given for deeper cuts (generally greater than 12') by including an additional temporary construction easement (usually 10' - 20'). The Town may require that the width of the permanent easement increase with a depth of sewer as determined by the Engineering Director for maintenance purposes.

Easements shall be fully accessible by rubber-tired vehicles in their entirety. The Town of Clayton may require stream fords for larger streams provided crossings are consistent with NCDEQ Division of Water Resources and USACOE requirements.

All off-site easements shall be acquired by the developer and dedicated to the Town of Clayton by recorded map and by deed of easement prior to approval of the project for construction.

No building, fence, or other obstruction shall be erected and no trees or shrubbery shall be planted on any easement.

R. **Testing:** See specification 02530 *Sanitary Sewer*; paragraph 3.9 *Testing* for testing requirements.

S. **Allowable Leakage**:

Condition	Allowable Leakage
Pipe diameters 18 inches and smaller, exposed or aerial piping	No visible signs of infiltration
Pipe diameters larger than 18 inches	50 gallons per inch diameter per mile per day

1.3.4 DESIGN – MANHOLES

A. **Location**

1. **General**: Manholes shall be installed on all mains 8 inches and larger. Manholes shall be installed at the end of each line, at all changes in grade, at changes in main size or alignment, at all intersections.

2. **Spacing**: Manholes shall be placed at distances not greater than 425 feet for all sewers.

B. **Diameter**

1. **Minimum Diameter**: The minimum diameter of standard manholes shall be 4 feet. The minimum diameter of drop manholes shall be 5 feet.

2. **Standard Manhole Diameter Based on Pipe Size**:

Line Size	Minimum Diameter
8 through 12 inches	4-foot in diameter*
15 through 30 inches	5 feet in diameter
36" inches	6 feet in diameter

Line Size	Minimum Diameter
42 inches	7 feet in diameter
48 inches	8 feet in diameter
54 inches	9 feet in diameter

***NOTE:** The number of connections, angle of connections, or diameter of connection(s) may require a larger diameter manhole.*

3. **Standard Manhole Diameter Based on Depth**:

Depth	Minimum Diameter
Manholes 0 to 12'-0"	4-foot in diameter*
Manholes greater than 12'-0" deep	5 feet in diameter with extended base
Manholes deeper than 20'0"	6 feet in diameter with extended base

***NOTE:** The number of connections or angle of connections may require a larger diameter manhole.*

4. **Extended Bases**: All manholes greater than 12 feet in depth shall also have extended bases with appropriate reinforcing.

5. **Moorbases**: Moorbases are not permitted.

6. **Cones**: Eccentric cones are required to be used on all mains.

7. **Manhole Material**: Unless otherwise permitted by the Engineering Director, manholes shall be precast concrete or polymer concrete manholes. Brick or block manholes are not permitted.

8. **Minimum drop across invert**: The minimum drop between manhole invert in and invert out is 0.10 feet on straight junctions (**Standard Detail 532.03**). Other drops (H), where there is no change in pipe size, can be computed by applying the following head loss (K) coefficients to the velocity head:

$$H = K\left(\frac{V^2}{2g}\right)$$, where

H = Vertical drop across invert of manhole (ft)
K = Head loss coefficient (from table below)
V = Average velocity in influent pipe (ft/sec)
g = Acceleration of gravity (32 ft/sec$^{2)}$

Condition	K
For bends at junctions of 25 degrees	0.30
For bends at junctions of 45 degrees	0.40
For bends at junctions of 90 degrees	0.60
For junctions of 3 pipes	0.80
For junction of 4 or more pipes	1.00

(Reference: King's handbook of Hydraulics)

Drops through manholes shall be indicated on the drawings by invert in and invert out elevations.

C. **Drop Type**

1. **Inside Drops**: A drop shall be provided for a sewer entering a manhole at an elevation greater than 30 inches above the invert of the manhole unless sewer pipe crown elevations match. Utilize a drop bowl connection as manufactured by RELINER/Duran, Inc. See **Standard Detail 532.09**.

2. **Outside Drops**: Not permitted.

3. **Service taps in manholes**: If a service is proposed in the manhole, utilize a drop bowl connection as manufactured by RELINER/Duran, Inc. See **Standard Detail 532.09**.

D. **Water-tightness**

1. **Manholes** shall be pre-cast concrete.

2. **Pipe connections to Manholes**: Inlet and outlet pipes shall be joined to the manhole with gasketed flexible watertight connections (rubber boots). See **Standard Details 532.01, 532.02, 532.03, 532.07, 532.09,** and **532.10.**

3. **Manholes in streets or adjacent to streets**: Manholes subject to flooding by street water or located in flood prone areas shall have watertight covers. See **Standard Detail C06.02**.

4. **All sanitary sewers in utility easements** (other than those running parallel to creeks and/or located in a flood plain): Unless otherwise approved by the Engineering Director, manholes shall be eccentric cones sections with standard frames and covers. All manholes rims must be 12 inches to 24 inches above adjacent grade. When height above adjacent grade must exceed 24 inches, use eccentric flat top section with frames cast in to top.

5. **Utility Easements running parallel to creeks and/or located in flood plains**: Unless otherwise approved by the Engineering Director, manholes shall be eccentric cone sections with bolt-down watertight frames and covers. All manholes rims must be 12 inches to 24 inches above adjacent grade. When the rim height exceeds 24 inches above grade, use eccentric flat top section, with frames cast into the flat top. Frames and covers shall be bolt-down watertight frames and covers. Manhole markers, furnished by the Town, shall be installed by the Contractor at each manhole.

   a. Manholes shall be designed for protection from the 100-year flood by one of two methods (see **Standard Detail 532.10)**:

      i. Manholes shall be vented 24 inches above the 100-year base flood elevation with every other manhole vented, or

ii. Manholes rims shall be 24 inches above the 100-year base flood elevation.

6. **Manhole Markers:** Manhole markers, furnished by the Contractor, shall be installed by the Contractor at all manholes outside of asphalt. See **Standard Detail 539.01**.

E. **Buoyancy:** Buoyancy shall be considered and flotation of the manholes shall be prevented with appropriate construction where high groundwater or flooded conditions are anticipated. For design purposes, assume water to top of manhole and that the manhole is empty.

F. See **Wetwells**, paragraph 1.3.7.C.2.c**,** for safety factors and buoyancy countermeasures to consider.

G. **Corrosion Protection for Manholes**:

1. Where corrosive conditions due to septicity or other causes are anticipated, consideration shall be given to providing corrosion protection on the interior of the manholes, as directed by the Engineering Director. Consequently, drops in interceptor lines or drops into interceptor lines shall be avoided. Drop manholes, if required, shall be provided upstream of interceptor line connection.

a. With approval from the Engineering Director, consideration should also be given to employing Polymer Concrete manholes and wet wells; round or rectangular as applicable. See Specification **Section 02530**, Section 2.2.18 for polymer concrete manhole product specifications.

2. Where high flow velocities are anticipated, the manholes shall be protected against internal corrosive erosion and displacement from impact.

3. See also paragraph 1.3.7, below.

H. **Inspection and Testing**: See technical specification 02530 - *Sanitary Sewer* for manhole testing requirements.

1.3.5 SEWERS IN RELATION TO STREAMS AND OTHER BODIES

All creek crossings, unless otherwise approved by the Engineering Director, shall be made with ductile iron pipe. Developer is responsible for obtaining all necessary permits to construct prior to Final Construction Document Approval.

A. **Materials**: Sewers entering or crossing streams shall be constructed of ferrous material pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment of grade and tested. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials, which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe**.**

1. **Sewers Paralleling Creeks**: Sewers paralleling creeks shall be below the stream elevation, such that lateral connections will be below streambed. In certain circumstances where rock is present, sections of the main may be raised to allow lateral connections above the streambed provided the ability to serve the upstream property is not compromised and the pipe crossing is designed sufficiently restrained to prevent line breakage by the dynamic **effects** of the stream flow. Sewers shall be placed outside of applicable Watershed and stream/river Buffers.

2. **Perpendicular Crossings**: All crossings require the use of casing and carrier pipe. Creek crossings shall be as near to perpendicular to the stream as possible. Sewers crossing creeks shall be placed below the streambed such that there is a minimum of 2-foot bury below the streambed. If the minimum 2-foot bury cannot be attained, either encase the sewer in concrete or design the sewer as an aerial crossing in accordance. Aerial crossings require prior approval of the Engineering Director. All crossings shall be subject to USACOE and **NCDEQ** Division of Water Resources approval and conditions. See **Standard Detail C07.02**.

B. **Buried Pipe Cover Depth**: The top of all sewers entering or crossing streams shall be at a sufficient depth below natural bottom of the streambed to protect the sewer line. The following cover requirements shall be met:

1. 1-foot minimum cover where the sewer is located in rock:

2. 2 feet of cover in other material unless ferrous pipe is specified. In major streams or rivers, more than 2 feet may be required; and

3. With approval of the Engineering Director, in paved stream channels, the crown of the sewer line may be placed below the bottom of the channel pavement.

C. **Grease Traps/Interceptor Tanks:** Where dictated by the business occupancy or mandated by either the Engineering Director or Health Department, provide grease interceptors sized for the appropriate flow/grease volume. **Standard Detail 535.01** shows a blow molded polyethylene hydromechanical interceptor for 75 to 500 gallons with protection compatible with a pH of 3. Concrete or acid resistant enamel coatings are not permitted on precast concrete tanks.

Sizing shall be in accordance with the tank manufacturer's instructions and shall include both flow rate and grease capacity calculations for a pump out frequency.

Buoyancy: Provide anti-flotation measures are to be provided where a localized seasonal high groundwater elevation is known or expected to exist.

1. **Common Buoyancy Countermeasures**: Where countermeasures are deemed necessary to meet the minimum factors of safety noted in paragraph 1.3.7.C.2.c, Buoyancy Safety Factors, designers can consider countermeasures such as:

a. Anti-flotation slabs (top, bottom, or both),

b. Increasing overburden depth.

D. **Aerial Crossings**:

1. All crossings require the use of casing and carrier pipe. Creek crossings above water level shall be constructed with piers or other approved support/carriage and shall be approved by the Engineering Director. The bottom of the pipe should be placed no lower than the elevation of the 25-year flood and, if lower than the 100-year BFE, crossings evaluated for impacts from the hydrodynamic forces of flood waters for the 100-year flood event. Ductile iron pipe with mechanical joints shall be required.

2. Proper joint technology, such as flanged or restrained, adequate supports to prevent excessive deflection and flexion or a combination of both shall be provided for all aerial pipe crossings. Supports shall be designed to prevent heave, overturning, uplift, and settlement. Supports shall be designed to withstand the hydrodynamic effects of the stream flow pressure using the following formula:

$$p = C_d\left(\frac{uV^2}{2}\right)$$

Where,
P = water flow pressure
u = density of water
V= flow velocity of flood
C_d =resistance coefficient of pier/obstruction; 0.7 Hemicyclic, 1.4 square for square ends, 0.8 for wedge shaped pier (AASHTO)
Notes:
1. Source: AASHTO LRFD Bridge Design Specifications (AASHTO)
2. In AASHTO, longitudinal resistance is defined as the product of the water flow pressure and the projected area of the bridge pier with respect to the water flow direction
3. Safety factor to be applied as applicable

If it is probable that the aerial pipe could be submerged by the stream flow, the effects of the flow pressure on the pipe shall also be taken into account when computing pier-overturning moments. For aerial stream crossings, the impact of floodwaters and debris shall be considered. In streams subject to flooding velocities greater than 5 fps, pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking of appropriate size in the bank. Provide applicable blocking computations and details.

3. Precautions against freezing, such as insulation and increased slope, shall be provided.

4. Expansion jointing shall be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize heaving. Similarly, special details may

be required between above ground and below ground sewer transition to account for seismic forces.

5. Computations:

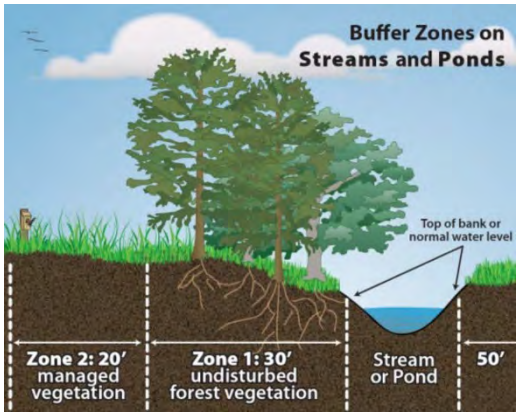
   a. Provide structural calculations for any elevated main and pier system where span of the main exceeds the joint length. Provide calculations for all aerial mains, and their supporting structures that are subject to hydrodynamic forces. Unless otherwise approved by the Engineering Director, calculations are to provide for a minimum safety factor of 2.5 against overturning and 1.5 for uplift. Calculations shall also address applicable seismic loads. Where stream is subject to floating debris such that the pipe system could be broken or separated by the impact forces, pipe joints shall be flexible restrained joints. Pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking in the bank. Provide applicable blocking computations and details for review.

6. When steel pipe is used for aerial pipe crossings, the pipe is to be coated inside and outside.

E. **Structures:** The sewer interceptors, manholes, or other structures shall be located so they do not interfere with free discharge of flood flows of the stream. Portions of manholes above grade subject to hydrodynamic forces of flooding shall be designed to resist the flood forces with a safety factor of 2.5 considerations shall be given for impact from debris. See paragraph 1.3.5.D above.

F. **Anti-Seepage Collars – wetland areas**: In areas where the sewer trench has the potential to drain wetlands, anti-seepage collars shall be installed. In these areas, a US Army Corps of Engineers 404 Wetland Permit and/or a NCDEQ DWR 401 Water Quality Permit may be required.

G. **Environmental - Buffer Requirements**: A minimum buffer separation of 50 feet shall be maintained between sewers and streams/waters classified as nutrient sensitive streams or watershed buffers (from normal high water). See also NCDEQ NCAC Title 15A 02T for other requirements regarding minimum separation with streams, lakes and impoundments and **Standard Detail C01.05** *Minimum Separation of Utilities and Other Feathers* for a visual display of separation requirements. Before crossing streams or ditches, working within 100 feet of private or public water supply sources or 50 feet of non-water supply ponds, lakes, or rivers, the designer shall verify whether the line is exempt and, if not, obtain a permit to encroach into a watershed or nutrient sensitive river basin buffer. Unless otherwise permitted, water or sewer mains crossing a stream, river, pond, or lake buffers are to be as near perpendicular as possible (the crossing is considered perpendicular if it



intersects the stream or surface water between an angle of 75 and 105 degrees). Do not disturb more than 40 linear feet (longitudinal) of a riparian buffer. Adhere to all of the following Best Management Practices in Zone 1 (the lower 30 feet beside the stream or water) during design/construction.

1. Woody vegetation is to be cleared by hand. No grading allowed.
2. Stumps to remain except in trench where trees are cut. Minimize disturbance to roots in buffer zone.
3. Backfill trench with the excavated soil immediately following installation.
4. Do not use fertilizer except for the one-time application to reestablish vegetation.
5. Minimize removal of woody vegetation, the amount of disturbed area, and the time the disturbed area remains disturbed.
6. Take measures to ensure diffuse flow of water through the buffer after construction.
7. In wetland areas, use crane mats to minimize soil disturbance.
8. Separate topsoil from the excavated material so that the original top soil is replaced over the excavated area.
9. And, other applicable requirements noted in the NCDEQ DWR permit.

1.3.6 PROTECTION OF POTABLE WATER SUPPLIES AND STORM SEWERS

A. **General**: See specification 02530 – *Sanitary Sewer*, Part 1- General, paragraph 1.11 *Project Conditions* for separation requirements between water mains and sewer mains/manholes and water mains and drainage structures/streams.

B. **Sewer/Well Conflict**: If a sewer main must be placed closer than 100 feet of the well, ferrous sewer pipe with joints equivalent to NCDEQ water main standards and pressure tested to 150-psi to assure weathertightness shall be used; however, no ferrous pipe gravity sewer, ferrous pipe force main, or manhole structure shall pass or be placed within 25 ft of a private well or 50 feet of a public water supply well, source or structure. If the sewer line must be installed within 25 feet of a well, the well shall be capped and the property shall be required either to connect to the Town of Clayton's water system, if available, or the existing well must be abandoned according to NCAC Title 15A 2C .0100, *Well Construction Standards*, latest revision, regarding guidelines for well abandonment and construction of a new well drilled meeting the setback requirements.

C. **Swimming Pools, Draining:** See ***Permits*****,** paragraph 1.1.2.B**.**

1.3.7 PUMP STATIONS

A. **General:**

No pump station will be allowed within 5,000 ft. of an existing extendable gravity line. Pump stations and force mains will be allowed only with the permission of the Engineering Director. Pump stations may be permitted if the design Engineer can demonstrate:

1. That gravity sewer is not possible, or

2. That the gravity sewer construction cost, if possible, exceeds the pump station construction and present value 20-year operational and maintenance cost by a factor of 2 ½, and
3. The Engineering Director grants permission for a pump station.

The estimated cost of both the gravity sewer and the pump station and O&M options costs must be prepared by a NC Professional Engineer.

Relocation and/or abandonment of an existing upstream pump station may be required.

Submersible Pumps: Pumps shall be submersible pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater. Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by either passing solids, trash, or stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material. **Standard Detail 534.02** for typical wetwell and valve vault arrangement.
Developer to provide spare submersible pump to Town as part of Town acceptance process

Station Layout: See **Standard Detail 534.02** (sheets 3 & 5) for typical pump station site layout.

Lift stations, at a minimum, shall include the following:

1. Wetwell inspection and testing: See **Specification Section 02530 *Sanitary Sewer*,** paragraph 3.9.B.9 *Manhole Vacuum Testing*, for manhole testing requirements.
2. Underground service by contractor from meter base and transformer (meter base and transformer provide by service provider).
3. Meter base and fusible service disconnect panel. Service to be 3 phase, 4 wire, 277/480V. Phase and voltage availability to be verified by project engineer based on site specifics.
4. Area light with switch control and photocell on 25’ class 5 Press treated pole (by Contractor).
5. Under hood panel LED light (for exterior use under rain hood). Power for area light to come from control panel.
6. Provide a red flashing alarm light with horn (minimum 90dB) and alarm silence for independent high water alarm circuitry and circuitry for station loss of power). The back-up alarm system shall operate off of a 12-volt battery connection in the event of power failure. The battery system is to include a trickle charger to ensure battery integrity.
7. SCADA panel with conduit for wiring and antenna. Mounting height of antenna to be site specific. Project Engineer to verify with Town. System to be reviewed by the Engineering Director for compatibility with the Town of Clayton system.

8. Stainless Steel junction box for pump power cable and liquid level cables. Junction box to be no more than 5 feet from hatch.
9. In wet well, use floats. Transducers are not permitted without back up float system. Provide PVC conduits for pump leads (provide separate conduits for each pump).
10. Provide a #8 ground to a driven ground rod (obtain 25 ohm resistance of less. Grounding to be per NEC.
11. Provide an automatic transfer switch for generator pump (not required when backup pump is used). Dri-prime pumps required before generators.
12. Provide condensate heater on thermostat inside pump control panel.
13. Manhole for grinder pump on influent line
14. Cushioned check valves for high head applications as determine by Engineering Director. Plug vale 6 inches and larger shall be ger activated.
15. Automatic air release valves, as applicable.
16. Primary liquid level control senser (mercury float) with hand-off-automatic (H-O-A) switches and an automatic alternator. Transducers not permitted without backup float system.
17. 3-phase voltage monitor, if applicable. Indication of 3-phase power fail.
18. Glycerin or Silicone filled discharge pressure gauges, sized appropriately, visible from top of vault with ¼ turn SS ball valve, direct tap.
19. Elapsed time indicators.
20. High pump temperature protection.
21. Pump run lights.
22. Motor overload resetter
23. TLVSS Surge suppressor by Siemens
24. Dual power supply auto switchover, etc.
25. Surge relief valve and return piping to wetwell.
26. A building to house control panel may be substituted for NEMA 4 enclosure and rain hood (as shown on Standard Detail 534.04). Building to include thermostatically controlled ventilation (fan and louver) and light. Building to be approved by Engineering Director.
27. Secondary bypass connection, installed below grade, with valves and a 4-inch Godwin style quick-connect; to include both suction and discharge connections.
28. An emergency pump connection with quick connect per **Standard Detail 534.07**.
29. A precast concrete valve vault sized based on the necessary clearances.
30. 110V GFCI protected waterproof duplex receptacles.
31. Stainless steel cable attached to pump bridle. Coil up extra length at hatch. Length to be sufficient to connect to hoist.
32. Non-Freeze Flush Hydrant. See **Standard Detail 514.08**.
33. Hoist with electric winch. Capacity to be equal to 3 times pump weight, minimum 1-ton capacity hoist and wench.
34. Wet well shall be checked for flotation and shall be ballasted as reqiured to prevent buoyancy. Top slab mus**t** have adequate thickness and be adequately reinforced **and** designed by a NC PE.
35. Station Start-up assistance and certification: Station start-up and certification shall include an operational/witness/drawdown test.
36. Control Panel Dead Front: Panels on the primary pump station, backup pumps or generators shall comply with NFPA 70E. The following elements, when applicable for the type system under consideration, at a minimum, shall be

accessible and located in front of the dead front panel and/or barriers installed to make the following accessible without being exposed to live conductors: Control/programming keyboards, all hand operated switches, H-O-A switches, disconnects, pump run lights and run time gauges, alarm silence, duplex receptacles, motor overload resetter, gauges (such as ammeter, temperature, fuel level indicator), indication of 3-phase power fail, handles, GFCI switch (on/off), circuit breakers, area light, SCADA, etc.

37. Backup Systems: The designer must provide backup service by a Dri-Prime backup pump. A backup generator can be substituted at the discretion of the Engineering Director. If a backup generator is provided, provide 1 spare pump/motor. The minimum design criteria for each option are outlined below.
38. Provide programmable auto-exercise cycle for both backup pump and generator, as applicable.

DRI-PRIME BACK-UP PUMP OPTION

Provide an auxiliary natural gas, LP gas, or diesel fired automatically activated stand-by dri-prime back-up pump with automatic reset, placed on site. All piping to be installed below grade. See **Standard Detail 534.02,** sheet 5. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. The Contractor shall provide a complete engine driven back-up pump. The back-up pump set shall consist of four-cycle, radiator-cooled, engine direct connected to pump, a unit-mounted control panel, unit-mounted fuel tank, all mounted on a common sub-base. Starting shall be from batteries, with capability to start the unit at 32 degrees Fahrenheit temperature. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but shall not necessarily be limited to, the following:

a. Permanent skid mounted trash pump for pumping raw sewage.
b. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
c. The pump offered shall be the manufacturer's standard production model.
d. Maximum solids handling size: 3 inches
e. Maximum duty point shall meet the suction, head, and flow requirements of the station at which the pump will be located.
f. Priming System: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated, and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts consistent with the site requirements, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The Town's engineer may require a demonstration.

g. Check Valve Pump shall be supplied with an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off.
h. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. A certified continuous duty engine curve shall be supplied to the owner/engineer.
i. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode.
j. Skid Base/Fuel Tank: Integral structural steel skid type fuel tank shall be sized with sufficient capacity to provide at least 24 hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
k. Exhaust: Exhaust system shall include a stainless steel critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values.
l. Sound Attenuated Enclosure: The engine and pump shall be completely enclosed with acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to 68 dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine/pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the unit shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.
m. Automatic Starting Control System: The engine shall be equipped with a factory installed microprocessor-based controller and designed to start/stop the engine at a signal supplied by high and low level floats.
n. Engine/Pump Control Specifications: The engine shall be started, stopped, and controlled by a high performance state-of-the-art digital controller. The controller shall be minimum NEMA 3R weatherproof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats. The pump controls shall provide the following minimum functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.
    i The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the panel.
    ii In automatic mode, the unit shall conserve energy and go to "sleep."
    iii The panel shall function as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.
    iv The panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.

v The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).
vi Manual-Automatic Button: In Manual Mode, Manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.
vii The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.
viii The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.
ix The panel shall have only one circuit board with 8 built-in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.
x Circuit breakers shall be provided with a built in control panel. Provide fuses or circuit breakers for battery charger and engine.
xi As applicable, standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form "C" relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.
xii The industrially panel shall withstand vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4°F to 176°F and an operating humidity range of 0-95% Non-Condensing.
xiii The control panel shall comply with NFPA 70E and shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; and running time meter, all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.

o. The back-up pump unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
p. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
q. Light: The unit shall include a single switch operated 12 VDC light within the enclosure.
r. Floats: The unit shall be supplied with 1 float assembly including 2 normally open (N/O) floats which shall integrate with the engine control panel via a single multi-pin plug. Bypass pump "on" float to be placed above the high water alarm.
s. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
t. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes; all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.

u. The backup pump shall be equipped with an automatic transfer switch to start pump and transfer operation to emergency operation in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
v. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
w. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
x. The Town must be furnished with one complete set of air, oil and fuel filters.
y. Provide 5-year warranty from manufacturer of Pump and Engine.

BACKUP GENERATOR OPTION

Provide an auxiliary natural gas, LP gas, or diesel fired automatically activated stand-by power generator source with automatic reset, placed on site. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. Generator shall have the capacity sufficient to sequentially start and run all pumps in the pump station. The Contractor shall provide a complete engine driven generator set. The generator set shall consist of four-cycle, radiator-cooled, engine direct connected to an alternating current generator, a unit-mounted control panel, all mounted on a common sub-base. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. The generation unit shall be capable of powering the pump motors starting current, electrical systems, instrumentation/controls and alarm systems, and other auxiliary equipment as may be necessary to provide for the safe and effective operation of the pump station. The generation unit shall have the appropriate power rating to start and continuously operate under all connected loads.
b. The generation unit shall be provided with special sequencing controls to delay lead and lag pump starts unless the generating unit has the capacity to start all pumps simultaneously while the auxiliary equipment is operating.
c. The generation unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
d. The generation unit shall be protected from damage when restoration of power supply occurs.
e. The generator shall be equipped with an automatic transfer switch to start generator and transfer load to emergency in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
f. The control panel shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; AC voltmeter; voltage adjustment; frequency meter; and running time meter. Switches and gauges shall be located in front of the dead front and/or barriers to

make them accessible without being exposed to live conductors and shall comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*.

g. Circuit breakers shall be provided with a built in control panel.
h. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
i. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
j. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes. Lights and gauges must be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*.
k. The automatic transfer switches must have a disconnect on the utility service main side.
l. The generator shall comply with the following minimum requirements:
    i Engine: Four-cycle, 4 cylinder, radiator cooled, at 1800 RPM. Starting shall be from batteries, with capability to start the unit at 32 degrees Fahrenheit temperature.
    ii Generator: Rating shall be continuous standby service at 0.8 power factor, at 1800 RPM.
    iii Voltage: Three-phase. KW rating to match facility needs.
    iv Engine shall be equipped with an isochronous governor as manufactured by Woodall.
    v Frequency regulation shall be less than 3-cycles from no-load to full load.
m. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
n. The generator set shall be enclosed with a factory-installed weather-protective housing (sound abating enclosure to 68db @ 23 ft.) Housing shall provide easy access to the engine-generator and instrument panel. Muffler to be designed so exhaust is not blown or sucked across the set by cooling air.
o. Included with the generator shall be a complete fuel system consisting of a fuel tank, fuel gauge, fuel lines, fuel pumps (if applicable), valves and any and all other items incidental to a first-quality installation.
p. Diesel Option: Provide integral sub-base double-walled diesel tank. The tank is to be UL approved closed-top dike type. The tank shall also be fitted with a leak sensor device. The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.
    Tank shall consist of the fuel tank separate and contained within the frame. No generator weight is to be supported by the tank. Provide a drain plug at one end of the rupture basin. Provide vibration isolators between generator set and tank assembly. Provide fuel low-level alarm remote mounted.
q. LP Option: The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.

r. Provide manufacturer's recommended anti-freeze and engine block heater, per manufacturer's recommendations, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements, adjustable if possible. Provide suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
s. Provide annunciator panels with visual and audible alarms to monitor and warn of emergency operation conditions affecting line and generator power sources.
t. Provide stainless steel super critical grade type exhaust silencer mounted inside of the generator enclosure for corrosion protection.
u. Provide amp meter, voltmeter, and frequency meters with phase switches. Meter gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*.
v. Provide fuses or circuit breakers for battery charger and engine.
w. Provide an automatic battery charger, static type, magnetic amplifier control with DC voltmeter, DC ammeter and potentiometer for voltage adjustment. The charger is to be completely automatic and rated for the type of battery use. The charging rate is to be determined by the state of the battery and reducing to milliamp current on fully charged battery. The charger shall be 120 V., single-phase, 60 cycle, AC input with 6-amp maximum output.
x. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
y. The Town must be furnished with one complete set of air, oil and fuel filters.
z. Provide 5-year warranty from manufacturer of Generator and Engine.
aa. Provide three bound (3-ring binder) sets of Operation and Maintenance Manual for all components relative to lift station generator.

B. **Station Design:**

1. Design of station shall be according to the provisions of NCDEQ, Division of Environmental Quality NCAC Section 15A 02T .0305, *Design Criteria, latest revision.*

2. The pump station shall have a 100% reserve peak pumping capacity (dual pumps) and be capable of pumping at a rate of 2.5 times the average daily flow rate with any one pump out of service. Pump on/off elevations shall be set to achieve 2 to 8 pumping cycles per hour at the average flow rate.

3. The power source, voltage and phasing shall be verified before ordering pumps.

4. The Designer shall evaluate the capacity of the receiving sewer main both at and from the point of discharge to a point downstream identified by the Engineering Director in order to determine if the systems can handle the additional sewer flow.

5. The pump station and force main must be sized to accommodate the total basin area that could gravity flow into it.

6. The Town of Clayton reserves the right to require odor control facilities at pump stations.

7. All control panels must be minimum NEMA 3R weatherproofed, constructed of stainless steel, and have weatherproof identifying labels attached with stainless steel screws.

8. The use of rigid conduit is required.

9. Where low head conditions exist, the designer may have to consider incorporating either an orifice restrictor plate or a Dresser plug valve (or approved equal with a published C_v factor) to induce a greater head. Calculations shall reflect the use of such devices and must be approved by the Engineering Director before incorporating the device.

10. Station Horizontal Surface Design:

    a. Both the bottom and top slabs of the wetwell shall be designed and reinforced to withstand the corresponding dead and live loads:

Table 1.3.7
Minimum Uniformly Distributed Live Loads

Location	Lbs./Sq Ft[4]
Roofs	See Note 3, below
Stairways	100
Equipment Room Floors	200[1,2]
Decks or floors on outdoor pumping stations	300 or H-20[2,3]
Suspended Steel/Aluminum Deck Grating	100 personnel, 300 if supporting equipment, machinery[2,3]

Notes:
1. Equipment room floors must be designed to allow for placement of the heaviest pump(s) or machinery place anywhere on the floor unless specific areas are designated for a particular piece of equipment.
2. Minimum floor point load: 2,000 lbs. or if greater the actual heaviest piece of equipment plus a safety factor for impact.
3. Use whichever is more critical and where mobile cranes or stationary hoists might be used, applicable loading to include impact loads if more critical than those listed above.
4. Refer to the NC State Building Code, Chapter 16 for other applicable Live Loads (Table 1607.1), Wind Loads, Lateral Soil loads, Earthquake Loads, Flood Load as well as moving loads and the applicable provisions of ASCE7-16, latest revision.

    b. If the top slab is being used as ballast to hold down the wet well, the slab shall be so designed and reinforced to withstand the buoyant forces imposed by the wet well, assuming flooding up to the bottom of the floor slab (see Wet Wells, paragraph 1.3.7.C, below).

c. The top slab and all equipment in both the wet well and valve vault must be installed a minimum of 2 feet above the 100-yr. BFE. See **Standard Detail 534.02**.

d. **Wet wells Founded on Rock**: Where a wet well is expected to be founded on rock, unless otherwise directed by a Geotechnical Engineer or the Engineering Director, provide a minimum 3-foot thick #57 stone base upon which to place or cast the wet well (as the rock may be fractured or contain seams which could shift of compress under loading, causing movement of the structures base).

e. **Insufficient Foundation Material**: If it is determined that the foundation material does not have sufficient bearing capacity to sustain the imposed structure's loads, and if other stabilizing methods are impracticable or unfeasible, foundation pile may be requred. The piles may be of wood, concrete, or steel but the use of wood piles should be restricted to those locations where the pile cut-off elevation is below the minimum ground water level. For pile support/design, employ the services of a Geotechnical Engineer.

f. **Dynamic Loads**: Where pump station walls or floors are expected to be impacted by pipe thrust loads, such walls and floors shall be designed to account for such forces and the resulting impact loads.

g. **Loading Conditions and Design Criteria**: The above noted items and loads should not be regarded as a comprehensive list. In many instances, unique site specific factors such as water conditions, station arrangement and location, pump type, pump and discharge arrangement, etc. will dictate modification of some of the load conditions referenced above to fit the specific site. Furthermore, stability and stress criteria vary according to the nature of the loading condition imposed on the structure. For the purpose of criteria application, there are 3 categories of loading conditions; usual, unusual, and extreme.

   i **Usual**: Usual conditions are defined as those related to the primary function of a structure and expected to occur during its life. For pumping stations, all of the operating flood conditions should be considered usual.

   ii **Unusual**: Unusual conditions are those which are of infrequent occurrence and of short duration. Construction conditions, maximum design water level condition, maintenance conditions, rapid drawdown condition, and blocked trash rack conditions are examples of unusual loading for pumping stations.

   iii **Extreme**: Extreme conditions are those whose occurrence is highly improbable and are regarded as emergencies, such as those associated with major accidents or natural disasters. For pumping stations, pumping station inundation and earthquake impact conditions should be considered extreme.

C. **Wet Wells:**

1. Wetwells shall have the interior walls painted in accordance with the technical specification Section 02530 - Sanitary Sewer, paragraph 3.10.C*, Wetwell Coating*.

2. Buoyancy shall be considered and flotation of the wetwells shall be prevented with appropriate construction where high groundwater conditions are anticipated.

    a. Computations: Provide buoyancy calculations to the Engineering Director. Without a localized geotechnical investigation, the design engineer shall assume water to top of structure and structure is empty. The weight of the liquid below pump off elevation may be counted.

    b. For some specific sites, particularly where wet wells are anticipated to be deep, the Engineering Director may require that a geotechnical investigation be performed at the station site to determine the soils and subsurface conditions. In such investigations, after the water table has been determined/established (allowing for seasonal and regional variations), the design engineer can identify whether or not flotation may or may not be factor in design and include such information in the buoyance calculations. The boring report can also provide information on rock depth and type, slope stability, recommend backfill and compaction requirements, etc. The design engineer shall err on the conservative side; accounting as well downward gravity forces (i.e. weight of walls and slabs, weight of soil on slabs [if applicable], weight of soil on extended bases, equipment weight inside structure, friction of soil-to-soil, skin friction, weight of inverts, weight of additional concrete inside structure, etc.).

    c. **Buoyancy Safety Factor**: Downward gravitation forced need to exceed upward buoyant forces. The minimum safety factor should be 1.1. In flood zone areas or where high groundwater conditions are known to exist, a safety factor of 1.25 can be used. Where maximum groundwater or flood levels are not well defined or where soil friction is included in flotation resistance, the Engineering Director may require/assign a higher factor of safety.

    d. **Common Buoyancy Countermeasures**: Where countermeasures are deemed necessary to meet the minimum factors of safety noted above, designers can consider countermeasures such as:

        i Base extensions,
        ii Anti-flotation slabs,
        iii Increasing member(s) thickness(es), or
        iv Lowering the wet well elevation and filling with additional concrete.

3. Surface water shall be directed away from the station pad in all directions.

4. The top of wetwells, and the access road to the site, shall be located a minimum of 2 feet above the 100-year base flood elevation.

5. Provide a screened exterior vent to prevent gas entry to either the panel or pump house enclosure.

6. Wetwell components shall be located such that normal maintenance and operation of the components can be performed without having to enter the wetwell.

7. Seal the electrical conduit running from the wetwell to the control panel to prevent gas entry into panel or pump house enclosure.

8. All bolts, mounting brackets, guide rails, pump lift cables, etc. must be stainless steel, sized to support the applicable static and dynamic loads imposed by the equipment. Pump lift chains are not permitted.

D. **Site**:

1. See **Standard Details 534.02, 534.03, 534.04**, and **534.07**.

2. Provide a service head, meter base, service connection, disconnect, and area light with photocell.

3. A minimum 18-foot wide all weather access road consisting of 2 1/2 inches of SF 9.5B and 8 inches of ABC is to be provided to the station with a turnaround area of sufficient size to accommodate turning of Town maintenance vehicles. Lift station lot must directly abut a publicly dedicated road wherever possible.

4. Provide an 8-inch thick concrete generator pad (see **Standard Detail 534.02**).

5. Unless otherwise allowed by the Engineering Director, all stations shall be fenced with an 8-foot high galvanized chain link fence with three strands of razor wire across the top. A minimum of an 18-foot or wider vehicular access, with two 9-foot hinged gates, shall be provided; gate to be lined up with the wet to provide straight in and out access. Depending on the location of the station, the Engineering Director may require the use of green privacy slats or other opaque screening in the fence. See **Standard Details 534.02** and **534.09**.

6. An area light on breaker, on a separate circuit from the pumps, shall be provided at the station. The light shall be a minimum of 100-watt sodium high-pressure (or as otherwise approved by the Engineering Director) with a minimum clear mounting height (ground to fixture) of 15 feet.

7. Minimum 10 ft x 10 ft x 8-inch concrete pad for odor control pad with drain and valve.

8. Emergency pump connection with quick-connect flange and resilient wedge **NRS** gate valve.

9. A metered potable water source with flushing hydrant (**Standard Detail 514.08**) and cross connection control is required, unless approved otherwise by the Engineering Director. Use a RPZ (Reduced Pressure Zone) device in an insulated and heated enclosure. See **Standard Detail 534.08**.

10. Provide a non-freeze shower w/ eyewash and concrete pad.

11. Access to all easements associated with the lift station site shall be provided. See **Standard Detail 534.02**.

E. **Force Mains**

1. Force main materials shall minimum conform to the table in paragraph *1.3.3.G, Collection System Design*.

2. Provide combination air valve air release valves at all high points with differential grade separation of 15 feet or more between high and low points. The same principals used to site air release valves on water mains shall apply to sewer mains. The designer should note that the air/vacuum valves used for water main applications are not suitable for sewer force main applications; occasionally requiring back flushing. See **Standard Detail 534.06** for typical sewer force main air release valve arrangement in manhole. If not provided in the design, the designer shall provide calculations to prove that a surge relief valve is not needed.

3. A valve or valve vault shall be placed outside of the pump station.

4. Plug valves are reqiured every 1,000 feet or as directed by the Engineering/Water Resources Director.

5. Sewer force main valve boxes shall have the valve cap marked SEWER.

6. Force Mains: Force mains shall be designed with appropriately located combination air release and vacuum valves at high points.

F. **Connection of Force Mains to Existing Manholes – Manhole Corrosion Protection**: To protect the manholes (cementitious materials and metals) from Hydrogen Sulfide (H_2S) and Sulfuric Acid (H_2SO_4) corrosion, the Engineering Director may require the Contractor to line the manhole at the force main connection, as well as the next 2 to 4 manholes downstream of the force main connection, or with the approval from the Engineering Director, employing Polymer Concrete manholes. See **Specification Section 02530,** Section 2.2.18 for polymer concrete manhole product specifications.

End of Section

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Boardwalk & Footbridge Design Criteria

SELECTED LINKS TO SECTIONS WITHIN THIS DOCUMENT

Section 1 – Introduction
Section 2 – Boardwalk, Trail Bridge/Footbridge Design Criteria
Section 3 – References
Section 4 – Appendix of Useful Design Tables

CementStabSubgrade Inspections

SECTION 1
INTRODUCTION

(Last revised 9/17/24)

The following division has been established to assist engineers with the design of Boardwalk and Footbridges where applications involve public structures within the jurisdiction of the Town of Clayton. The methods, procedures, design factors, formulas, graphs, and tables presented in this division are intended to establish the minimal guidelines for design. However, as may be applicable to the specific nature and location of the Boardwalk or Footbridge, other more restrictive design criteria may be warranted by one of the applicable referenced codes and/or agencies noted in paragraph 2.1, below.

Alternative design methods may be considered by the Engineer/Designer on a case-by-case basis; however, there should not be extensive variations from the criteria and procedures within this division without the expressed approval of the Engineering Director.

1.1 TOWN OF CLAYTON ENGINEERING DIRECTOR

The Engineering Director shall be responsible for interpretation and implementation of the Boardwalk and Footbridge Design Criteria for the Town of Clayton. Approval from other applicable agencies may be required.

Provided that Boardwalks and Footbridges are located on publicly maintained Right-of-Way and/or established public easements where such structures are an integral part of a public transportation system, the Town may accept Boardwalks and Footbridges for maintenance if they have been designed and constructed in accordance with the provisions of this specification or as otherwise instructed in writing by the Engineering Director.

SECTION 2
BOARDWALK & FOOTBRIDGE DESIGN CRITERIA

2.1 RELATED REFERENCE DOCUMENTS/AGENCIES

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. North Carolina State Building Code, latest edition.

C. Currently adopted edition of the NC State Building Code, Chapter 11, *Accessibility*.

D. International Code Council *ICC/ANSI A117.1*, latest revision (pertaining to accessibility requirements for general site and building elements)

E. AASHTO's *Standard Specifications for Highway Bridges*, latest edition.

F. AASHTO LRFD *Guide Specifications for Design of Pedestrian Bridges*.

G. FHWA *The Manual of Uniform Traffic Control Devices*, latest revision.

H. *National Design Specification for Wood Construction* (NDS), latest revision.

I. American Institute of Steel Construction (AISC), latest edition.

J. American Institute of Timber Construction (AITC), latest edition.

K. *Building Code Requirements of Reinforced Concrete*, American Concrete Institute (*ACI 318*), latest revision.

L. NCDOT Greenway Construction Standards *Minimum Pavement Design Recommendations for Greenways*.

M. NCDOT *Complete Street Guidelines*, latest revision.

N. NCDOT *Greenways and Multi-Use Paths;* where traffic is limited to occasional use by pick-up trucks. Except, refer to **Standard Detail 401.03** for minimum pavement section requirements.

O. NCDOT *Multimodal Planning & Programing*.

P. Occupational Safety and Health Administration (OSHA), CFR 29, Part 1910, Subpart D, latest revision.

Q. Town of Clayton Specification Section *02275 – Trenching, Backfilling, & Compaction of Utilities*.

R. Town of Clayton, Specification Section *02200 – Earthwork.*

S. Town of Clayton, Specification Section *02630 – Storm Drainage*.

T. Town of Clayton, Specification Section *02740 – Base Course & Paving*.

U. US Access Board *Americans with Disabilities Act, Accessibility Standards* (Official website of the US Government), latest version

V. US Forest Service - *Accessibility*

2.2 DEFINITIONS

A.	**AASHTO**	American Association of State Highway and Transportation Officials
B.	**ADA**	Americans with Disabilities Act
C.	**DWR**	Division of Water Resources
D.	**MUTCD**	Manual of Uniform Traffic Control Devices
E.	**NCDOT**	North Carolina Department of Transportation
F.	**NCDEQ**	North Carolina Department of Environmental Quality
G.	**NCDPS**	North Carolina Department of Public Safety, Division of Emergency Management
H.	**NCSBC**	North Carolina State Building Code
I.	**OSHA**	Occupational Safety and Health Administration
J.	**USC**	Unified Soil Classification

2.3 PURPOSE

A. **Boardwalks**: Boardwalks provide the opportunity to place a trail through an unavoidable environmentally sensitive area with the least amount of impact by either the trail or the trail users. Also, boardwalks are typically required when crossing wetlands or other poorly drained areas. They are often constructed of wooden planks or recycled material planks that form the top layer of the boardwalk. Recycled material has gained popularity in recent years since it lasts much longer than wood, especially in wet conditions. A number of low-impact support/foundation systems are also available that reduce the disturbance within wetland or poor soil conditions.

B. **Footbridges**: Footbridges are used where the span of water is too large for a culvert, where there is a wetland area or other environmentally sensitive area, or to cross a stream or river. Some bridges often used for multi-use trails include simple or multi-span stringers (steel, timber, or reinforced concrete), prefabricated timber or steel bridges, and suspension bridges.

C. **Greenways:** Refer to section 6.10 Pedestrian Facilities of the Town of Clayton UDO for greenway design criteria.

2.4 BOARDWALK OR FOOTBRIDGE DESIGN ENGINEER.

A. The Boardwalk or Footbridge design shall be performed by a Professional Engineer licensed in the State of North Carolina.

B. All easements, encroachments, and/or permits (including building permits) required for on-site and off-site facilities, must be obtained by applicant prior to beginning work.

C. Record drawings will be required prior to acceptance of routine maintenance/warranty of the Boardwalk or Footbridge.

D. See **Standard Detail 4.07** for clearances for boardwalks and footbridges, as applicable.

2.5 BOARDWALK DESIGN

A. Foundation: The foundation normally consists of precast concrete pedestals, timber posts or pilings, or augured piers (screw anchors).

B. Abutment: Footbridge or boardwalk abutments shall consist of decay resistant material such as precast or cast-in-place concrete, pressure treated timber, or reinforced concrete masonry units with stone cladding.

C. When possible, incorporate seating and signage elements into design per the Town of Clayton's standards or preferences.

D. Where hazardous drop-offs or uses exist (such as active rail lines), provide railings and/or fences.

E. In multi-use trails or greenways serving cyclists, avoid pickets in handrails or guardrails as pickets pose a hazard for bicyclists. See Table 2.1 below. Also, consult with other local, state and federal codes to determine when it is appropriate to install railing should there be a more restrictive requirement.

F. See Tables 2.1 and 2.2 for other design criteria.

2.6 FOOTBRIDGE DESIGN

A. Providing a standardized footbridge design is impractical due to the varied field conditions often encountered in boardwalk and footbridge design. A crossing can encounter a fixed man-made object such as a road or trail, a stream (which can vary in width, flow and turbulence), a swale, a buffer, or the crossing may even need to be curved or skewed. For these and other reasons, each footbridge must be individually designed by a NC Professional Engineer taking into consideration the site constraints and the minimum design standards provided herein.

B. Certain styles or material may be required to be employed in the footbridge design in order to match the theme of a surrounding development or one prescribed by the Town of Clayton.

C. The footbridge design shall follow the minimum design requirements below in addition to the requirements of AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, latest edition, as applicable.

1) Bridge Styles & Types: See paragraph 2.9, Footbridge Styles & Types for an example of the typical styles of prefab bridges preferred by the Town.

D. If a corridor already contains a bridge, such as an abandoned rail bridge, a licensed Professional Engineer shall be consulted, at the developer's expense, to assess the structural integrity before deciding to remove or reuse the bridge. A report of the findings and opinion shall be provided to the Town.

E. Foundation/Abutment:

1) Foundation and abutment design should be performed by a Professional Engineer licensed in the State of NC.

2) For bridge spans greater than 25 feet, the Designer shall consult with a Geotechnical Engineer for possible subgrade investigation and foundation design; particularly where micro piles, helical piering or pneumatically driven piles may be required.

3) The bridge abutment shall be placed a minimum of 10 feet back from the top of the bank of any stream. The Engineering Director may require armor along the bank to protect the abutment.

4) The minimum free board from the bottom of the low chord to the BFE shall be 3 feet. However, overtopping of bridge structure will be acceptable with the approval of the Engineering Director provided the design takes into consideration the dynamic and buoyancy forces imposed by the moving water with allowances for debris impact.

5) Bridge piers are not permitted to be placed in the stream channel.

6) Flood Study: Where boardwalks or footbridges are crossing a mapped floodplain with a floodway, a CLOMR, LOMR or a No-Net Rise (NNR) certification shall be obtained prior to construction. Permits shall be obtained from the NC Department Emergency Management and the USACOE as applicable.

7) Wetlands: Where wetlands or streams are expected to be impacted, those features shall be delineated, confirmed by the USACOE field representative, and when applicable, surveyed and mapped. The applicable permits (nationwide or individual), shall be filed and permits secured prior to construction of any boardwalk or footbridge construction. Permits shall be obtained from NCDEQ and the USACOE as applicable.

8) Erosion and Sedimentation Control: When applicable, an erosion and sedimentation control plan must be filed with the Town of Clayton and a permit bust be in hand prior to disturbance.

9) Coordinate setting of bridge deck elevation with the permit requirements of the applicable permits (i.e. wetlands, buffers, etc.)

F. See Tables 2.1 and 2.2 for other design criteria.

2.7 MINIMUM DESIGN CRITERIA FOR BOARDWALKS AND FOOTBRIDGES

To ensure that boardwalks and footbridges placed on public rights-of-way or easements are constructed to achieve the desired life and performance, the designer shall incorporate the minimum design guidelines specified herein. The designer shall consider all internal and external forces imposed by the loading conditions that the boardwalk or footbridge system may encounter which includes, but is not necessarily limited to gravity loads (pedestrian, equestrian, and maintenance equipment), rolling loads, impact, hydrostatic pressures, seismic, pedestrian/guardrail forces, etc.

Other Design Considerations: The Design Engineer shall evaluate the need for testing of the subgrade soils as applicable to the type of structure and/or foundation system being designed. Testing may include, but is not necessarily limited to, placement of test piles, static load pile tests and pull-out tests (e.g., using hydraulic jacks or reaction frames), DCP's, and other methods so determined by either the Structural or Geotechnical Engineer. Prior to construction, contractor shall submit Geotechnical test reports, as applicable, indicating the results of such tests required for the appliable foundation elements. Test reports to be sealed and signed by an NC Licensed Professional Engineer.

Prior to commencing design, the Project Engineers shall contact the Town's Engineering Department to determine if any portion or all of the boardwalk and footbridges proposed in a project shall be required to be designed and constructed to a higher load requirement than the minimum loads specified in Table 2.2, and the applicable referenced footnotes at the bottom of the Table.

A. **Geometric Design Criteria**:

Table 2.1

Boardwalk & Footbridges Geometric Design Criteria	
Element	**Requirement**
Lanes	Two-way, multi-purpose (coordinated with trail requirements)
Clear Travel Width	10 feet minimum. For shared-use facilities, a minimum width of 14 feet is recommended (to be confirmed with Engineering Director).
Maximum Longitudinal Grade	2%; however, minimum longitudinal grade for bikeway/greenway roadside ditch = 2%.
Cross-slope	If not free draining, 2%
Deck Openings	Openings in the surface of Boardwalks and Footbridges shall be small enough to prevent passage of a ½-inch diameter sphere. Elongated openings should be placed perpendicular, or as close

Boardwalk & Footbridges Geometric Design Criteria	
	to perpendicular as possible, to the main direction of travel.
Design Speed	20 mph (no superelevation)
Minimum Horizontal Radius	95 feet
Boardwalk Intersections	Minimum 20-foot isosceles triangle return at corners (see photo below) 
When is a railing needed?	**Non ADA:** Whenever the height of boardwalk exceeds 30 inches (measured vertically from the deck floor to the grade below any point within 36 inches horizontally of the edge of the Boardwalk or Footbridge. **ADA:** Meet the requirements of ICC/ANSI A117.1 and Chapter 11 *Accessibility* of the NC State Building Code, latest edition as applicable. See paragraph 2.8.C Rail System Selection for rail selection.
When are curbs required on Footbridges?	Whenever the drop off height from the top of an elevated boardwalk or footbridge to the adjacent grade exceeds 4 inches. When a curb is required, the curb height is to be minimum 6 inches (nominal in terms of timber curbs).
Railing Height	Pedestrian hand railing height = 42 inches
	Multi-use, Bicyclist or Equestrian Rail Height = 54 inches above the deck
	Rub rail for cyclists = 33 to 36 inches above the deck
	See paragraph 2.8 for railing requirements.
Picket Style	Horizontal top, middle and bottom rail (Type 3 railing system). Avoid picket style due to safety hazard to bicyclist. See paragraph 2.8.C Rail System Selection.

[a]A walking surface with a rise of more than 1 inch per 20 inches (>5%) must be treated as ramps (ref US Access Board, *Guide to the ADA Accessibility Standards*).
[b]Meet ADA requirements where applicable. For accessible areas, where the grade is 5%, it is recommended that a level rest area, 5 feet in length, be placed at intervals of not more than 200 feet.

A. Table 2.2 summarizes the minimum structural design criteria required by the Town of Clayton.

Unless otherwise advised by the Engineering Director, the minimum structural design criteria for boardwalks and footbridges shall comply with Table 2.2, below. However, where vehicular access is not prevented by permanent physical methods/barriers,

there are applications where the live load may need to be increased or decreased based on the occupancy/usage type (e.g., emergency vehicle [H5 truck loading {10-kip vehicle}, H10 truck loading {20-kip vehicle}, or even HL-93 truck {tandem}], ramp, overlook, etc.). In those cases, the Engineering Director will make the determination as to the required Design Vehicle.

Table 2.2

Boardwalk & Footbridges Minimum Design Criteria	
Design Loads	
Element	**Live Load**
Boardwalks (decks/floors, stringers, and their immediate supports):	90 psf[5](patterned to produce the maximum load effects)
Footbridges (decks/floors, stringers, and their immediate supports):	90 psf[5] (patterned to produce the maximum load effects)
Equestrian Load (decks intended to carry equestrian loading):	A patch load of 1-kip[5] over a square area measuring 4 inches on a side
Girders, trusses, arches, and other members:	
Spans 0 to 100 feet	90 psf[5] (patterned to produce the maximum load effects)
Spans > 100 feet	Refer to AASHTO Standard Specification for Highway Bridges
Maintenance Vehicle Options	
Clear Deck Width of 7 to 10 feet[1] (Town to determine design vehicle prior to design):	A. 5,000 lb. Small Maintenance Vehicle such as a Gator or Mule (2,500 lbs. per axle; minimum 96" wheel base), where vehicular access is prevented by permanent physical methods/barriers. or
	B. AASHTO H5 Design Vehicle (8,000 lb. single axle) where vehicular access is not prevented by permanent physical methods/barriers patterned after design vehicle, or
Emergency Vehicle Option; Clear Deck Width Over 10 Feet[1] (Town to determine necessity prior to design):	C. Minimum AASHTO H10 Design Vehicle (e.g., ambulance or fire truck) where vehicular access is not prevented by permanent physical methods/barriers.
Handrails (Pedestrian Loading):	
Uniform Load (applied in any direction at the top)	50 plf[2]
Concentrated Load (applied at any direction at the top)	200 lbs[2]
Handrail Components:	
Intermediate rails, balusters, panel fillers	50 lbs[3]

Curb Loading (Boardwalks):	50 plf at top of curb
Handrail/Guardrail kick plates	See Section 2.8.B *Railing Systems* for applicable for kick plates requirements
Vehicle Barrier Systems (Town to determine need prior to design):	Refer to AASHTO Standard Specification for Highway Bridges
Vehicular Curb Loading:	500 plf at top of curb
Wind Load on Structure	
For girder and slab type footbridges	Refer to AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges
Other type bridge structures:	Refer to AASHTO Standard Specification for Highway Bridges
Soil Bearing Capacity (for concrete footings):	2,000 psf minimum
Stability	**Minimum Factor of Safety**[4]
Sliding	1.5
Overturning	2.0
Bearing Capacity	2.0
Wind (Importance Factor 1.15)	1.33
Impact (from moving vehicles)	1.3
Uplift (Buoyancy)	1.5
Flood Load	See ASCE7-22 supplement on flood loads (latest), or when applicable, (AASHTO) *Load and Resistance Factor Design Bridge Design Specifications*
Other Considerations:	
Deflection (unfactored pedestrian live load or unfactored horizontal wind load):	For spans other than cantilever arms, the deflection of the bridge due to live or wind loading shall not exceed 1/360 of the span length (1/500 of the span length recommended)[4]
Seismic	Refer to AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges

1. This is the minimum Design Load. Verify loads of actual equipment utilizing the structure are below this load requirement or increase design load requirement. Refer to *AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges*.
2. Uniform or concentrated design loads shown are based on the requirements of the North Carolina State Building Code as may be applicable to ramps, decks, or observation platforms. Load is not to be applied current with uniform load on handrail. Otherwise, handrail/guardrail lateral design force and top chord stability shall follow the applicable requirements of *AASHTO LRFD Guide Specifications for the Design of*

Pedestrian Bridges or OSHA 1910, Subpart D, as applicable to the type of rail. See paragraph 2.8.C for rail selection criteria and thus the design requirement.

3. Load applied horizontally on an area equal to one square foot, including openings and space between rails (based on the requirements of the North Carolina State Building Code as may be applicable to ramps, decks, or observation platforms).
4. Where governing design code is more restrictive, the governing design code shall apply. Safety Factors shown are ASD (Allowable Stress Design).
5. In combination with a load factor of 1.75.

B. Other Design Considerations:

1) **Vehicle Considerations:** Determine the type of vehicles (maintenance [light or heavy], emergency vehicles) that will utilize the facility from the Engineering Director and design accordingly. See Table 2.2, above for live load requirements for the respective vehicles. For emergency vehicles, the clear deck width will need to be adjusted to accommodate the width of the vehicle plus a minimum clearance of 18 inches on each side.

2) **Internal Forces**: Self-straining forces arising from contraction or expansion resulting in temperature change, shrinkage, change in moisture content, creep in component materials, movement due to differential settlement or combinations thereof.

3) **Load Combinations**: Applicable loads shall be considered, including gravity (uniform and concentrated), flood, earthquake, and wind, in accordance the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero. Refer to combinations identified in *AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges.*

4) **The Potential for Slick Surfaces:** Wood surfaces in shaded or moist areas may become slick or even grow moss. A means for mitigating such localized surface conditions should be considered and discussed with the Engineering Director. Below are two options for consideration or discussion with the Engineering Director.

a. **Hardware Cloth Option:** Slick surfaces can be managed by attaching ½-inch hardware cloth (wire mesh), especially where boardwalks follow creek grade. Fasten with 1 ½-inch heavy-duty rust resistant staples placed approximately 8 to 12 inches apart. Upper side of mesh should have wires perpendicular to direction of travel. Ends of hardware cloth should be tucked between deck boards or lapped over sides and stapled every 4 to 6 inches.

b. **Textured Paint:** Depending on site conditions, a sand-based textured coating can be applied to mitigate slick surfaces. Submit cut sheets on product, application rates, and adherence to substrate material.

Annual Cleaning: An annual cleaning (after autumn leaves fall) is recommended.

5) **Permitting**: The designer shall be responsible for ensuring all regulatory permits either will be or have been acquired where Boardwalks or Footbridges encroach into wetlands, riparian buffers, or other environmentally sensitive area.

6) **Lighting of Boardwalks and Footbridges**: The Town may require that certain corridors be lit for safety. Lighting standards, spacing, and fixture specifications will be provided to the Designer by the Engineering Director when such is required.

7) **Recycled Plastics:** The designer shall submit to the Engineering Director, with their design, a cut sheet showing the physical characteristics and properties of the recycled plastics upon which the design is based. Life expectancy as well as deflection and creep shall be specifically addressed. Prior to their incorporation into a Boardwalk or Footbridge design, the Town of Clayton shall first approve the materials to be used.

8) **Unauthorized Vehicular Access to Boardwalks and Bridges:** A lockable P-Style Swing gate shall be placed at both ends of a boardwalk and footbridge to prevent unauthorized entry of vehicles. See sheets 1 and 2 of **Standard Detail 4.03**.

9) **Railing Selection**: See paragraph 2.8.C, Railing System Selection, below.

10) **Footbridge/Boardwalk Approach Pad**: Provide a 10-foot long 6-inch thick 3000 psi concrete approach pad at each end of a boardwalk or footbridge. Width of approach pad to match width of boardwalk or footbridge. Provide temperature expansion/contraction reinforcement in the form of a sheet(s) of 6x6-W2.9xW2.9 welded wire fabric (WWF). Concrete to be air-entrained. See **Standard Detail 4.01**.

11) **Maintenance:** Longevity and maintenance costs shall be considered in the selection of the style and composition of a boardwalk or footbridge. The Engineering Director may request a life cycle cost analysis be performed by the designer for non-standard bridges and particularly when specialty bridges are being considered.

2.8 BARRIERS/ GUARDRAILS/ HANDRAILS FOR BOARDWALKS & FOOTBRIDGES:

A. Where the difference in elevation between the top of the boardwalk or footbridge deck and the adjacent lower grade exceeds 30 inches, a handrail or guard barrier shall be provided. Guard rails that perform as a protective barrier for pedestrians shall be a minimum of 42 inches in height.

Where handrails or guard barriers are required, the rails or barriers are to be designed to accommodate the applicable lateral loads based on the type of facility, the rail system type and the governing design code (i.e. Building Code, AASHTO, or OSHA): See Table 2.2, above.

B. **Railing Systems:** The three basic rail systems[1] typically used for footbridges include:

1) **Type 1 – Urban and high-risk areas (NC State Building Code-based)**: The 2018 NC State Building Code refers to the rail systems attached to buildings as guards. These rail systems are recommended on boardwalks and footbridges in urban settings or high-use areas. The NC State Building Code section 1015, "Guards," requires stairs, platforms, and landings higher than 30 inches to have guards (rail systems) at least 42 inches high measured from the leading edge of the tread to the top of the guard. A 4-inch sphere must not pass through the lower 34 inches of the rail system and an 8-inch sphere must not pass through the upper area of the rail system (between 34 and 42 inches). The NC State Building Code section 1607.8 , "*Loads on Handrails, Guards, Grab Bars, Seats and Vehicle Barriers*," requires guards to resist a uniform load of 50 pounds per linear foot or a single concentrated load of 200 pounds applied in any direction at the top of each rail. The guard must transfer the load through the supports to the structure. Most intermediate rails are mounted vertically so children cannot climb on them.

2) **Type 2 – Rural and moderate-risk areas (AASHTO-based)**: Rail systems on boardwalks or footbridges frequently used by pedestrians, bicycles, light maintenance equipment and other moving traffic should meet the AASHTO *LRFD Bridge Design Specifications*. Section 13, "Railings," requires a railing (rail system) at least 42 inches high for pedestrian traffic and at least 54 inches high for bicycle or equestrian traffic. A 6-inch sphere must not pass through the lower 27 inches of the rail system and an 8-inch sphere must not pass through the upper area of the rail system (higher than 27 inches). A safety toe rail (AASHTO's terminology) or curb should be provided. The rail spacing requirements do not apply to support rails and posts for chain link or metal fabric fence. Mesh in chain link or metal fabric fence should have openings no larger than 2 inches. The design live load for railings is 50 pounds per linear foot, both transversely and vertically, acting simultaneously. In addition, each rail will be designed for a concentrated load of 200 pounds, which shall act simultaneously with the above loads at any point and in any direction at the top of each rail. Note: Railings (rail systems) are normally constructed horizontally so wheels will not catch on them.

3) **Type 3 – Remote and low-risk areas (OSHA-based)**: The NC State Building Code and AASHTO rail systems are complicated and expensive and should be used for moderate- to high-risk areas. Remote locations are typically low-risk areas and may not have to meet these standards. The Occupational Safety and Health Administration (OSHA, CFR 29, Part 1910, Subpart D) refers to a rail system as a standard railing. These systems provide safety without complication and are widely accepted for protecting industrial workers. While OSHA requirements apply only to the workplace, its standard railing is a good choice for public trail bridges in low-risk areas. OSHA 1910.23 requires every open-sided floor or platform 4 feet or more

[1] USDA Trail Bridge Rail Systems, December 2007 (updated by Appian Consulting Engineers, PA)

above the adjacent floor or ground level to be guarded by a standard railing on all open sides except where there is an entrance to a ramp, stairway, or fixed ladder. A standard railing shall consist of a top rail, intermediate rail, bottom rail, and posts. The railing shall have a vertical height of 42 inches nominal from the upper surface of the top rail to the floor, platform, runway, or ramp. The intermediate rail shall be about halfway between the top rail and the floor, platform, runway, or ramp. A bottom rail (called a toe board by OSHA) is recommended. For pedestrian trail bridges, the vertical distance between steel rails must not exceed 19 inches and the vertical distance between wood rails must not exceed 15 inches. The completed rail system shall be capable of withstanding a load of at least 200 pounds applied in any direction at any point on the top rail. Note: For Type 3 Railing Systems, rails will be required when the decking is greater than 30 inches above the lower adjacent grade as stated in Table 2.1.

4) **Types 1, 2, & 3 – Multi-use or Bicyclist Rail Height**: Multi-use, bicyclist or equestrian rail height shall be a minimum of 54 inches above the deck with a rub rail for cyclists at 33 to 36 inches above the deck.

C. **Railing System Selection**:

Type 1: Type 1 railings systems are to be used for boardwalks and footbridges where the vertical separation is greater than 30 inches, the conditions pose a significant fall hazard (such as overpasses or stream and river crossings) and the facility traffic is limited to pedestrian, bicycle, equestrian, and small maintenance equipment. The applicability or use of this type railing system shall be determined by the design engineer and approved by Engineering Director.

Type 2: Type 2 railings systems are to be used for boardwalks and footbridges where the vertical separation is greater than 30 inches, the conditions pose a significant fall hazard (such as overpasses or stream and river crossings) and the facility will serve pedestrians, bicycles, equestrian, small maintenance equipment, H5 loading or larger maintenance equipment, and/or emergency equipment. If a vehicle barrier is required in addition to or as part of a pedestrian railing system by the Engineering Director, the barrier design shall conform to the requirements of Table 2.2. The applicability or use of this type railing system shall be determined by the design engineer and approved by Engineering Director.

Type 3: Type 3 railings systems are to be used for boardwalks and footbridges where the vertical separation is greater than 30 inches and traffic is limited primarily to rural areas serving pedestrian, bicycle, equestrian, and small maintenance equipment. Unless otherwise necessitated by design requirements, trail type or directed by the Engineering Director, Type 3 railing systems shall the standard rail type typically employed for boardwalks and footbridges.

2.9 FOOTBRIDGE STYLES & TYPES:

A. For the purpose of consistency, the footbridge style or type shall take the appearance one or more of the following. For consistency, try to utilize a single style along the entire trail under design consideration unless the span dictates

otherwise. Other styles and configurations will be considered by the Engineering Director on a case-by-case basis.

Short Span Bridges (8 to 40 feet+/- span)

Timber or Steel Stringer Style
(Glulam Bridge shown)
May be single or multi-span



Medium Span Bridges (40+/- to 100 feet+ Span)

Pratt Half Through Truss

(See also **Standard Detail 4.09** for example of a bow Pratt half through truss)



Warren Half Through Truss



Specialty & Long Span (100 to 200+ feet)

Specialty Bridges

(As approved by the Engineering Director considering topography, aesthetics of crossing, location, span, materials, and maintenance). Specialty bridge systems may be part of a multi-span system made up of trusses or a single truss with stringer-style single or multi-span approaches.

Tied Arch Style shown…



Tied Arch Style with timber suspenders shown…



2.10 MATERIALS:

Acceptable Materials for Boardwalks and Footbridges shall comply with **Table 2.3**, below. However, the Engineering Director will consider alternate material substitutions on a case-by-case basis.

The contractor shall submit manufacturer's shop drawings, sealed by a NC Professional Engineer, for Town review prior to the manufacture or fabrication of any engineered prefabricated structure(s).

Table 2.3

Acceptable Materials	
Boardwalk & Footbridge Material	
Material	**Product or Manufacturer**
Decking Material:	Non-toxic pressure treated wood or an approved equal.
	Naturally rot resistant timber (such as Red Cedar)
	Other structural alternative approved by the Engineering Director (TimberSIL is not permitted)

Acceptable Materials	
Boardwalk & Footbridge Material	
	Precast concrete boardwalk system (such as PermaTrak™)  Standard widths = 3'-9", 7'-6", 11'-3" and 15"-4". Thickness = 4" and 5 ½" Engineered Code Requirements: H5 (10,000 lbs.). Slip Resistant
Timber Joist, Beam, &Truss Material	Non-toxic pressure treated wood
	Naturally Decay Resistant Timber such as Red Cedar or Black Locust
Steel Joist, Beam &Truss Material	Self-weathering steel, galvanized, Aluminum or paint on non-weathering steel surfaces meeting NCDOT *Standard Specification for Roads and Structures*, latest revision, Sections 442 *Painting Steel Structures* and 1080 *Paint and Paint Materials*, as applicable; color approved by Engineering Director.
Foundation Support:	
Precast Footings	Precast concrete pedestals with precast concrete bases on an approved subgrade or improved foundation.
Dimensional Piles:	Non-toxic pressure treated timber
	Recycled Plastic Posts
	Precast reinforced concrete
Galvanized Helical Steel Piers	Augur-like helical anchors that can be screwed in to the soils with little disruption to the ecosystem environment such as manufactured by Hubbell Power Systems – Civil Construction.
Galvanized Pin Foundations	Patented by Pin Foundations, Inc., the system uses 4- to 8-foot long sections of galvanized pipe sections driven into the ground at diagonal angles. Pins can be pulled up to permit adjustments or removal. See **Standard Detail 4.08** for an example of this foundation system.
Concrete Foundation	Precast Concrete abutments (slabs, tees, or special cast shapes)

Acceptable Materials	
Boardwalk & Footbridge Material	
	Cast-in-place reinforced concrete (rubbed or textured finish or clad in natural stone veneer)
	Reinforced concrete masonry block (clad with natural stone veneer if visible to public)

2.11 POSTING A LOAD RATING

A. Each approach of each section of boardwalk or footbridges shall be posted with sign indicating the structures safe load rating. Signs shall match the greenway system signage. Town approval is required for all regulatory, warning and wayfinding signs.

2.12 OVERPASSES:

A. Where footbridges are designed as overpasses (over existing roadways), safety should be the primary consideration.

B. A signature bridge should be considered in areas of high visibility, such as over major roadways. This may include special LED lighting elements for nighttime enhancement/visibility.

C. Aesthetically pleasing galvanized steel debris netting (or other approved style and color) shall be provided on both sides and up over the top to at least 8 feet above the decking. Mesh shall be minimum 2x2.

D. For shared-use facilities, a minimum width of 14 feet is recommended.

2.13 UNDERPASSES:

A. An underpass is typically a crossing constructed beneath a new or existing roadway. Underpasses work best with favorable topography when they are open and accessible and exhibit a sense of safety.

B. An underpass can also be a trail crossing beneath an existing overhead roadway bridge where such structures cross streams or rivers. The underpass must be large enough to accommodate trail users and meet the prescribed clearances. In some cases, a protective housing, such as a multi-plate arch or other similar structure, can be placed beneath the overpass to protect trail users from falling objects (such as railroad ballast, etc.).

C. Proper drainage must be established to avoid pooling of stormwater; however, some underpass can be designed to flood periodically (after significant rainfall).

D. Ideal vertical clearance of the underpass is 12 feet but, with the approval of the Engineering Director, may be reduced to no less than 10 feet.

E. The width of an underpass shall be at least 12 feet.

F. Headwalls and wingwalls are required on both ends.

G. Longitudinal grade shall be no less than 1%.

H. Illuminance: Underpasses should have a daytime illuminance of 10 foot-candles minimum achievable through artificial and/or natural light provided through an open gap to the sky between two sets of highway lanes. Nighttime illuminance level: 4 foot-candles.

I. See **Standard Detail 4.10** for example of underpass.

SECTION 3
REFERENCES

1. *2018 NC State Building Code, or latest edition.*

2. American Association of State Highway and Transportation Officials (AASHTO), *Standard Specifications for Highway Bridges*, Washington DC, 17th Edition.

3. American Association of State Highway and Transportation Officials (AASHTO), *AASHTO LRFD (Load and Resistance Factor Design) Guide Specifications for the Design of Pedestrian Bridges,* 2nd Edition, w/ 2015 Interim Revisions.

4. *USDA Trail Bridge Rail Systems*, December 2007

5. OSHA Part 1910 Subpart D, Waling-Working Surfaces 1910.23, Guarding Floor and Wall Openings and Holes, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9715

SECTION 4
APPENDIX OF TABLES

The following Tables are being provided for both convenience and reference.

Table A.1

Approximate Soil Design Parameter Ranges					
Wall Backfill Classification	**Common Description**	**UNSC Classification**	**Φ range**	**γ range (moist)**	**Comments**
Good	Sand, Gravel, Stone	GW, GP, GM, GC, SW, SP	32° - 36°	100 -135 pcf	Poor grading lowers weight (i.e. #57 stone)
Moderate	Silty Sands Clayey Sand	SM, SC	28° - 32°	110 – 130 pcf	Moisture Sensitive
Difficult	Silts, Low Plastic Clays	ML, CL, CL	25° - 30°	110 – 125 pcf	PI<20 LL<40
Bad	High Plastic Silts & Clays, organics	CH, MH OH, PT	0° - 25°	50 – 110 pcf	PI<20 LL<40

TABLE A.2

PRESUMPTIVE LOAD-BEARING VALUES[c]				
CLASS OF MATERIALS	**VERTICAL FOUNDATION PRESSURE (psf)**	**LATERAL BEARING PRESSURE (psf/ft below natural grade)**	**LATERAL SLIDING RESISTANCE**	
			Coefficient of friction[a]	**Cohesion (psf)[b]**
1. Crystalline bedrock	12,000	1,200	0.70	--
2. Sedimentary and foliated rock	4,000	400	0.35	--
3. Sand gravel and/or gravel (GW and GP)	3,000	200	0.35	--
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	--
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	--	130

a. Coefficient to be multiplied by the dead load.
b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2 of the 2018 NCSBC.
c. Excerpted from Table 1806.2 of the 2018 NCSBC

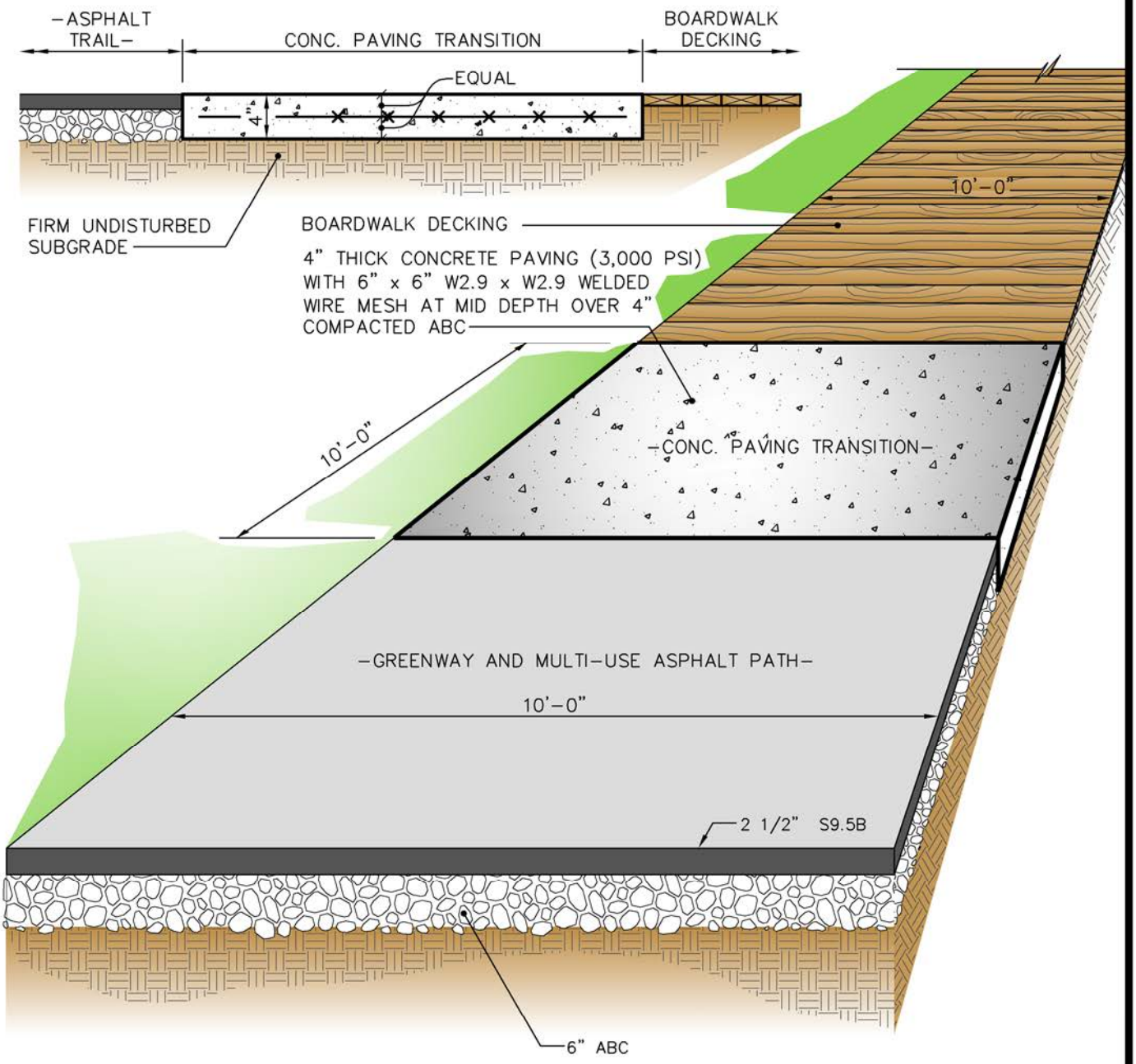
TABLE A.3[d]

LATERAL SOIL LOAD			
DESCRIPTION OF BACKFILL MATERIALS[c]	**UNIFIED SOIL CLASSIFICATION**	**DESIGN LATERAL SOIL LOAD[a] (pound per square foot per foot of depth)**	
		Active pressure	**At-rest pressure**
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravely sand mixes	SW	30	60
Poorly grades clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	CL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.
b. Unsuitable as backfill material
c. The definition and classification of soil materials shall be in accordance with ASTM D2487.
d. Excerpted from Table 1610.1, 2018 NCSBC

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NOTES:

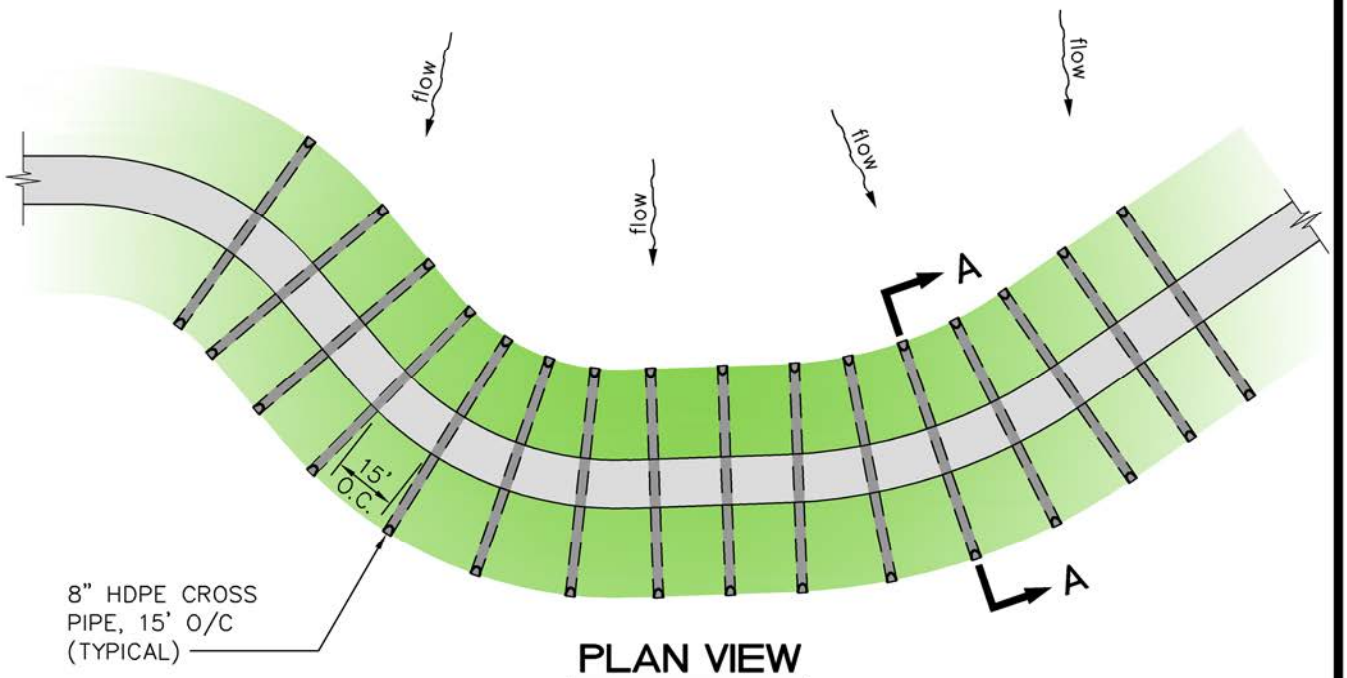
1. Concrete transition pad to be a minimum of 3,000 PSI @ 28 days air entrained.

TOWN of CLAYTON

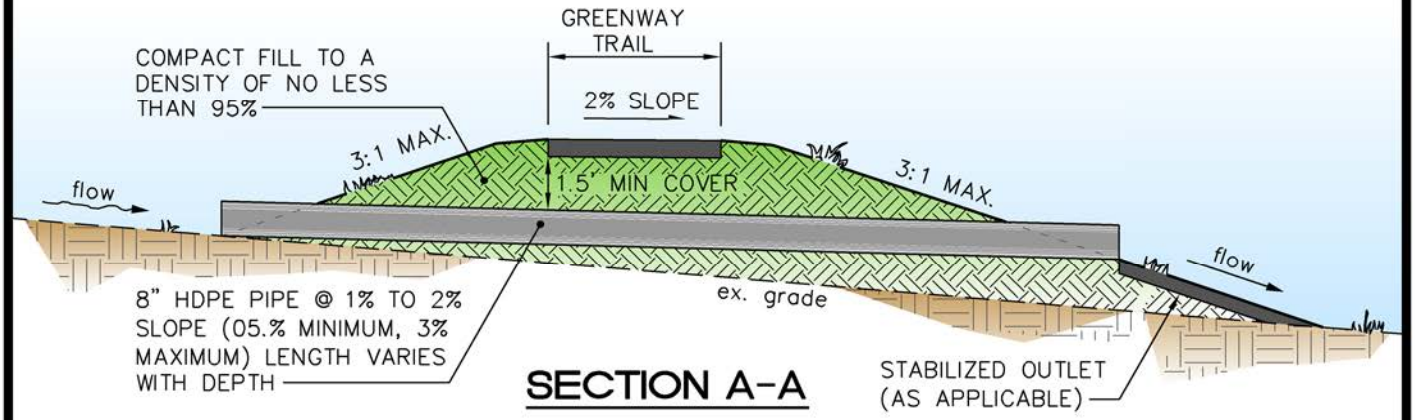
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD BOARDWALK APPROACH

SCALE:	DETAIL #
Not To Scale	2 4.01
REVISION DATE: Feb, 2015	SHEET #: 1 of 1



PLAN VIEW



SECTION A-A

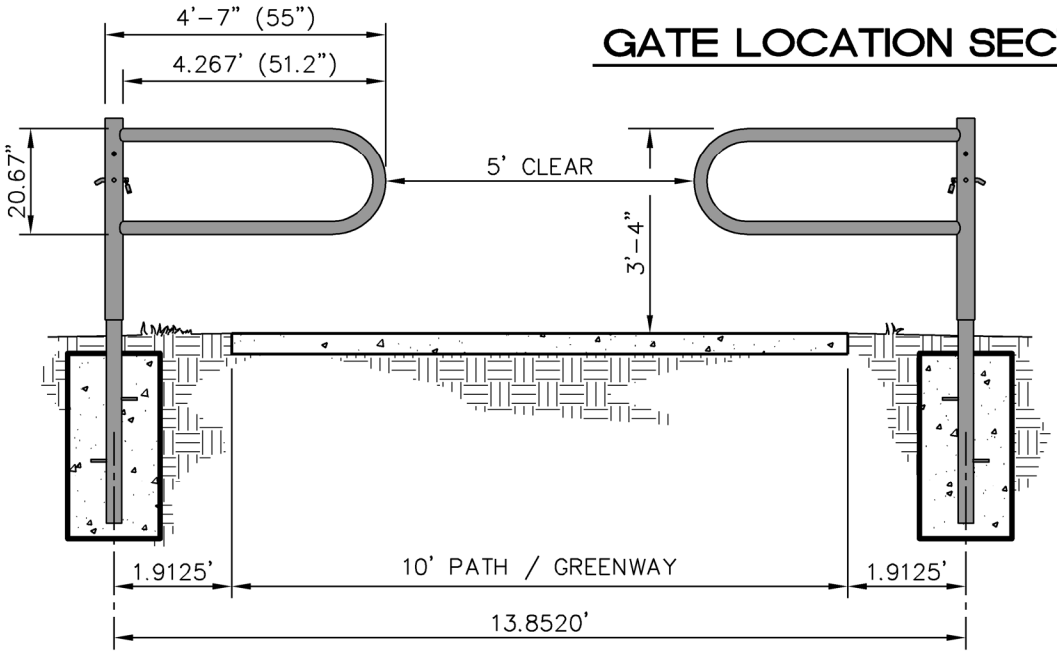
TOWN of CLAYTON

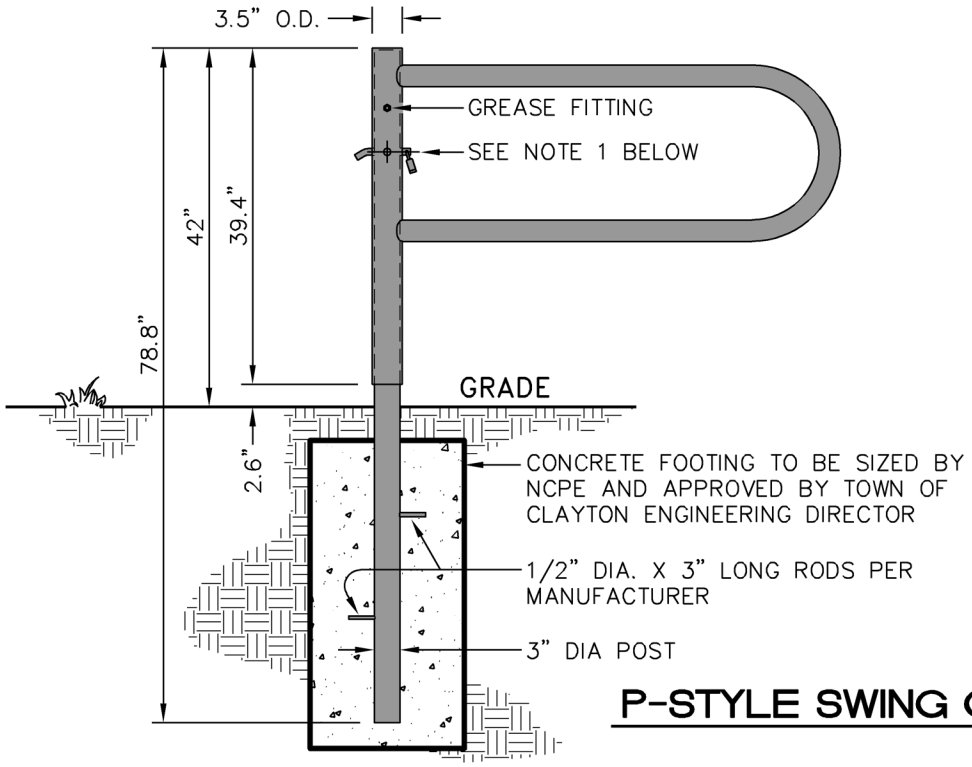
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

GREENWAY TRAIL DRAINAGE CROSSING

SCALE: Not To Scale	DETAIL # 24.02
REVISION DATE: Feb, 2015	SHEET #: 1 of 1

GATE LOCATION SECTION





P-STYLE SWING GATE

NOTES:

1. 3/4" Diameter bent pin w/ provision for padlock. (Padlock provided by Town of Clayton) 90° turning / locking increments (both posts/gates).
2. (2) P-Style Swing Gates / Posts per "PARIS EQUIPMENT MANUFACTURING LTD." Model: B35-Gate-42X55. www.peml.com Finish to be Polyester powder top coat steel components or Hot dipped galvanized. TOC Engineering Director approval required.

TOWN of CLAYTON

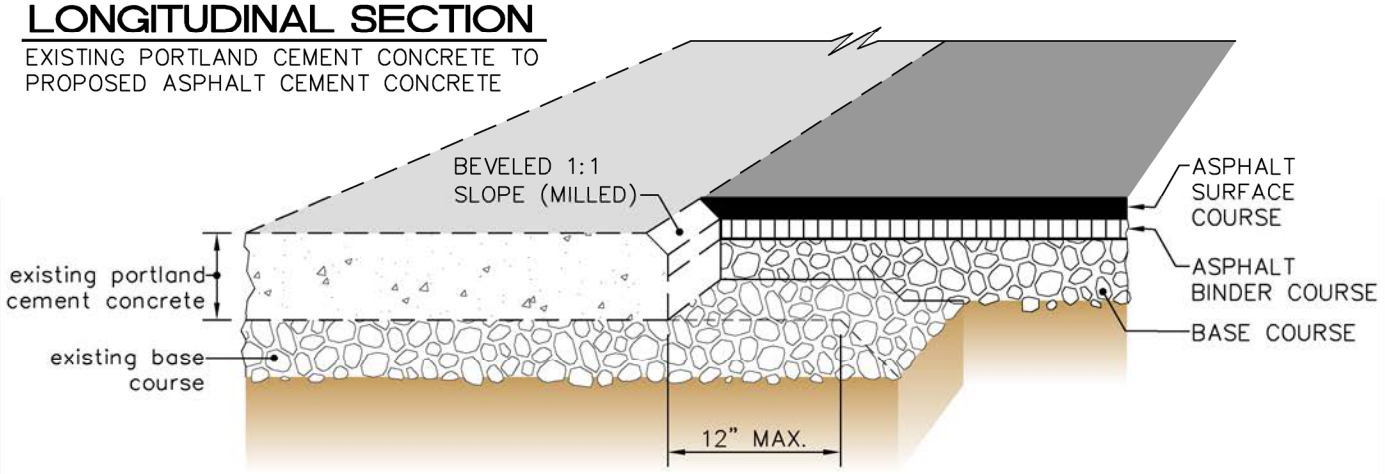
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MULTI-USE PATH STREET TIE-IN W/ P-STYLE SWING GATES

SCALE:	DETAIL #
Not To Scale	24.03
REVISION DATE: March, 2024	SHEET #: 2 of 2

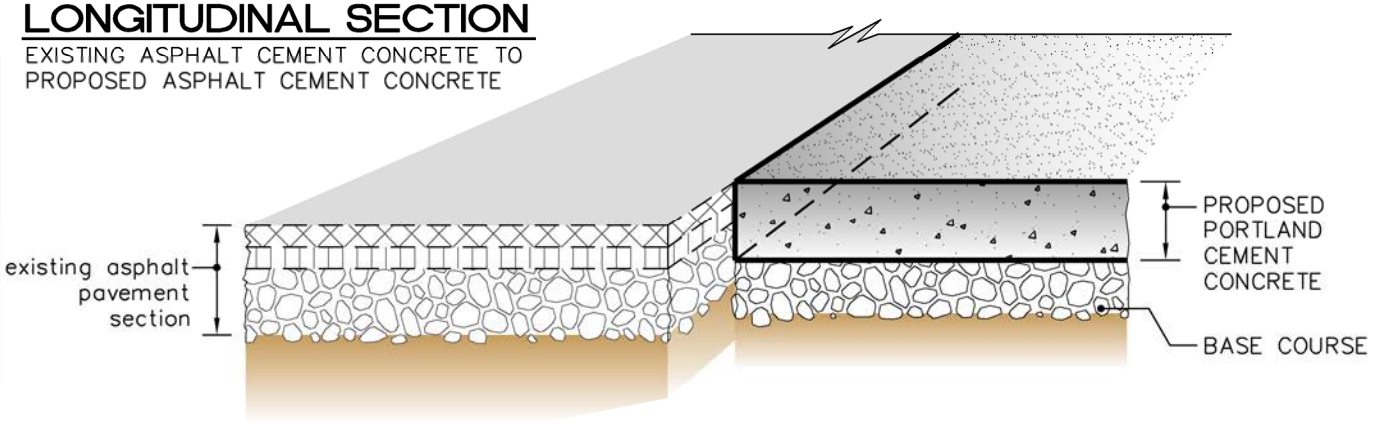
LONGITUDINAL SECTION

EXISTING PORTLAND CEMENT CONCRETE TO
PROPOSED ASPHALT CEMENT CONCRETE



LONGITUDINAL SECTION

EXISTING ASPHALT CEMENT CONCRETE TO
PROPOSED ASPHALT CEMENT CONCRETE



TOWN of CLAYTON

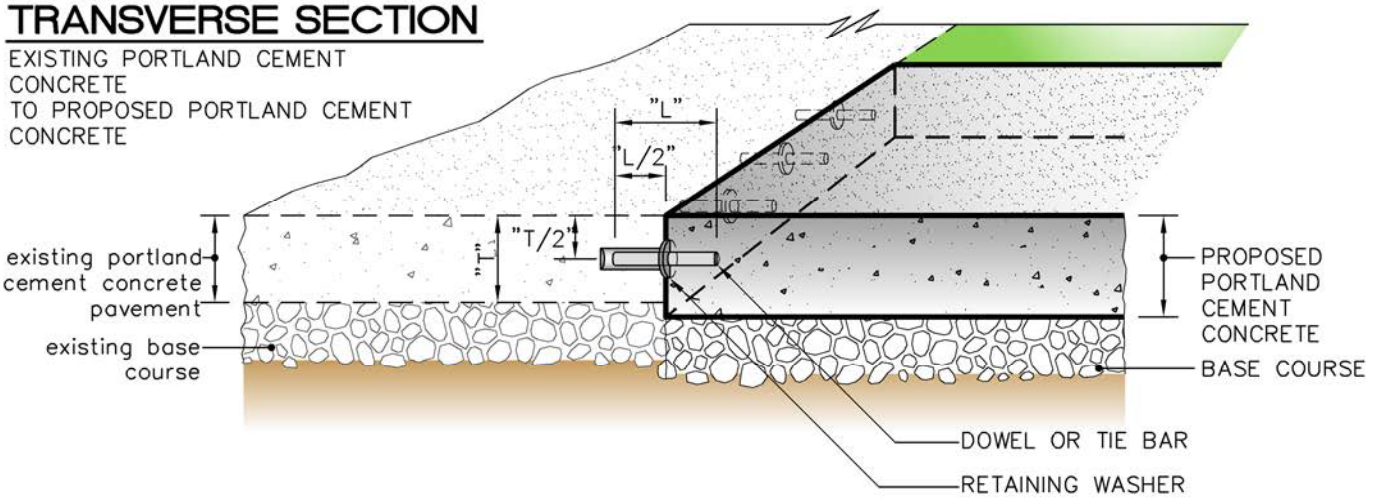
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYING PROPOSED PAVEMENT TO EXISTING PAVEMENT

SCALE:	DETAIL #
Not To Scale	24.04
REVISION DATE:	SHEET #:
July, 2023	1 of 2

LONGITUDINAL OR TRANSVERSE SECTION

EXISTING PORTLAND CEMENT CONCRETE TO PROPOSED PORTLAND CEMENT CONCRETE



NOTES:

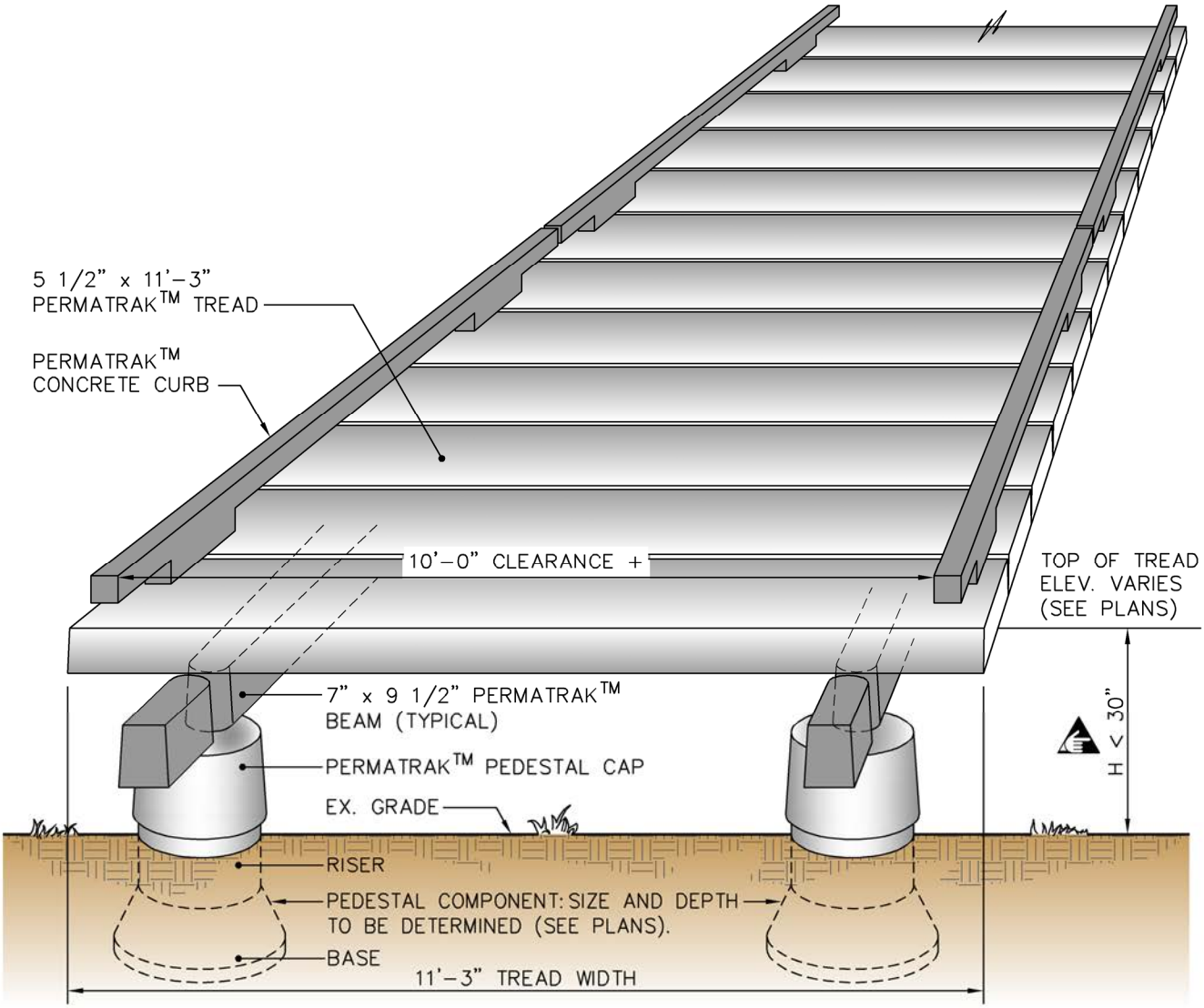
1. Joint pavements as shown on this detail or as directed by the Engineering Director.
2. Place tie bars (deformed steel bars) along the longitudinal joints at 30" on center. Place dowel bars (smooth steel bars) along the transverse joints at 12" on center. The placement and/or spacing of tie or dowel bars may be modified by the Engineering Director. Measure the holes, to accept these bars, the O.D. of the bar plus 1/8" in diameter and 1/2 the length of the bar plus 1" unless otherwise specified by the manufacturer of the adhesive. Use retaining washers (nylon, plastic or composite) on all bars to hold the adhesive material in place. The retaining washers shall be: I.D. = bar O.D., O.D. = hole I.D. + 1/4" min., thickness = 1/16" min. See NCDOT standard drawing 700.01 for bar sizes and other joint related information. Provide adhesive bonding material specified by Section 1081 of the 2018 NCDOT Standard Specifications for Type 3A adhesives.
3. See standard detail 401.03 for pavement composition and for other specific information.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYING PROPOSED PAVEMENT TO EXISTING PAVEMENT

SCALE:	DETAIL #
Not To Scale	24.04
REVISION DATE:	SHEET #:
July, 2023	2 of 2



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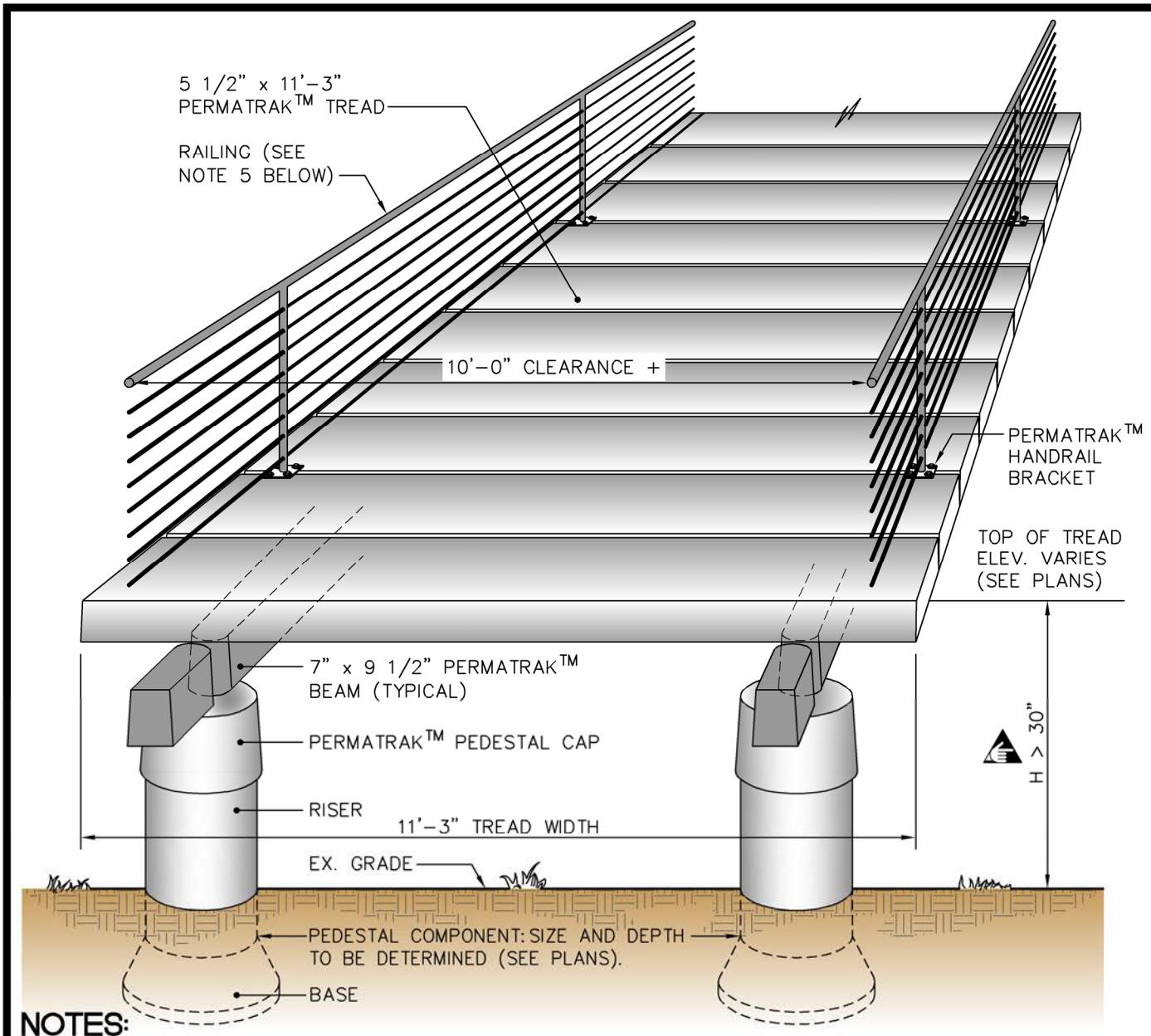
1. PermaTrak foundations may consist of a standard Cap, Riser and Base (as shown on this detail) for shallow bridge clearances. Where wetlands or poor soils are encountered or a greater clearance is necessary requiring the use of piles, the foundation shall consist of pile system comprised of a standard PermaTrak cap placed on top of pilings [Pile type, size and depth to be determined by design engineer]). Coordinate cap/pile connection with manufacturer.
2. PermaTrak boardwalk systems shall be installed per the manufacturer's installation instructions and as shown on the design drawings as approved by the Engineering Director.
3. Precast abutments either manufactured by PermaTrak™ or compatible with PermaTrack™ Beam/Tread must be used at termination ends of boardwalk. Specialized abutment design may be necessary depending on site conditions.
4. Longitudinal beam spans and Base/Riser/Cap spacing shall be determined by analysis and shown on the design drawings.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PermaTrak™ ELEVATED BOARDWALK SECTION (HEIGHT < 30") OPTION

SCALE:	DETAIL #
Not To Scale	2 4.05
REVISION DATE: Feb, 2015	SHEET #: 1 of 1



NOTES:

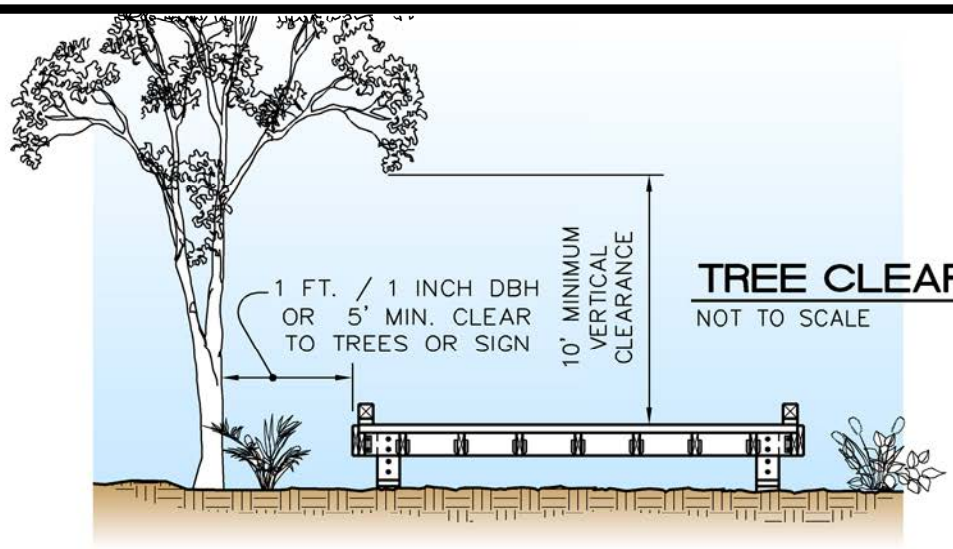
1. Bases should be set on a prepared subgrade of compacted sand, clean gravel, or concrete per the installation drawings. Bases shall be set level and to the elevation noted on the design drawings. If soft subgrade is encountered, improve as directed by either a Geotechnical Engineer or the project engineer.
2. Precast concrete curbs shall be installed on all elevated boardwalks with a grade separation greater than 4".
3. When the vertical grade separation exceeds 30 inches, hand/guard rails are required (see design manual). In such cases, employ PermaTrak handrail brackets to support/brace handrail posts see standard Detail 4.06.
4. All lifting equipment that comes in contact with the precast components should have rubber padding.
5. Handrail / Guardrail Kickplates: See section 2.8.B of "Boardwalk & Footbridge Design Guidelines."

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

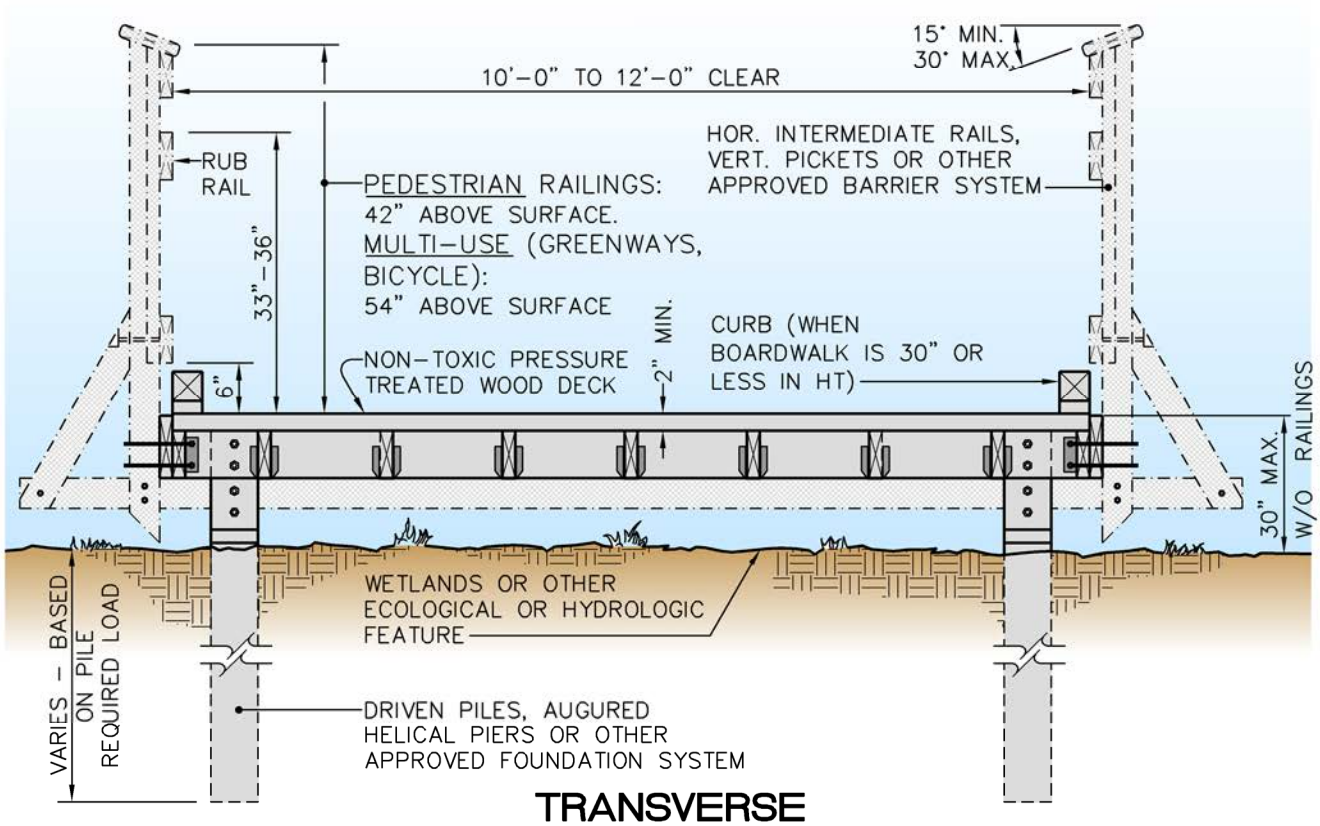
PermaTrak™ ELEVATED BOARDWALK SECTION (HEIGHT > 30") OPTION

SCALE:	DETAIL #
Not To Scale	2 4.06
REVISION DATE: April, 2024	SHEET #: 1 of 1



TREE CLEARANCE

NOT TO SCALE



TRANSVERSE BOARDWALK SECTION

NOT TO SCALE

NOTES:

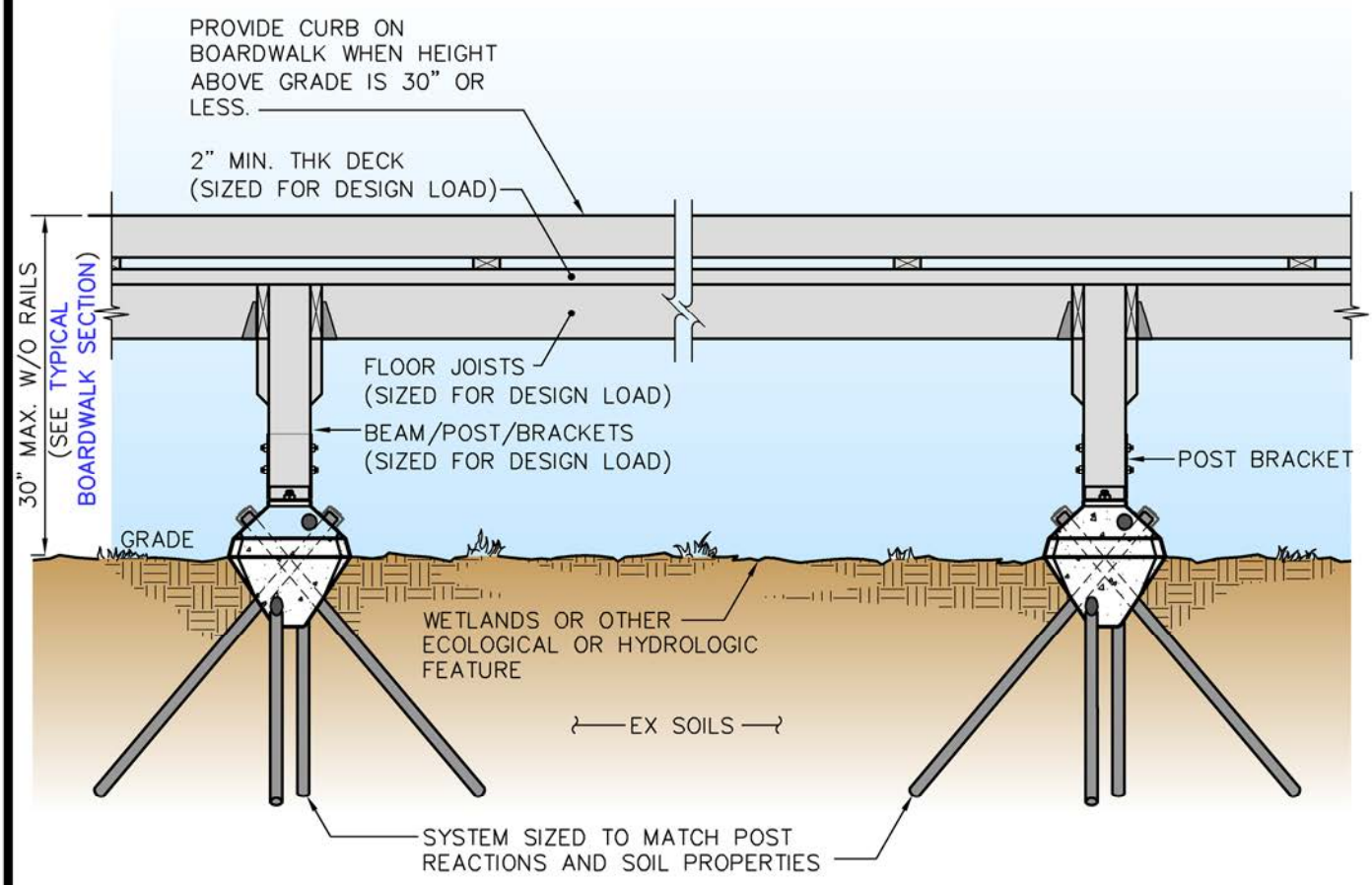
1. Refer to the Town of Clayton Greenway Boardwalk and Foot Bridge Design manual for design criteria.
2. When height of boardwalk exceeds 30", designer to evaluate need for lateral bracing.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

ALT. BOARDWALK / FOOT BRIDGE FOUNDATION SYSTEM OPTION

SCALE:	DETAIL #
Not To Scale	24.07
REVISION DATE:	SHEET #:
July, 2023	1 of 1



LONGITUDINAL BOARDWALK SECTION SHOWING ALT. FOUNDATION SYSTEM SUPPORTING TIMBER POSTS

NOTES:

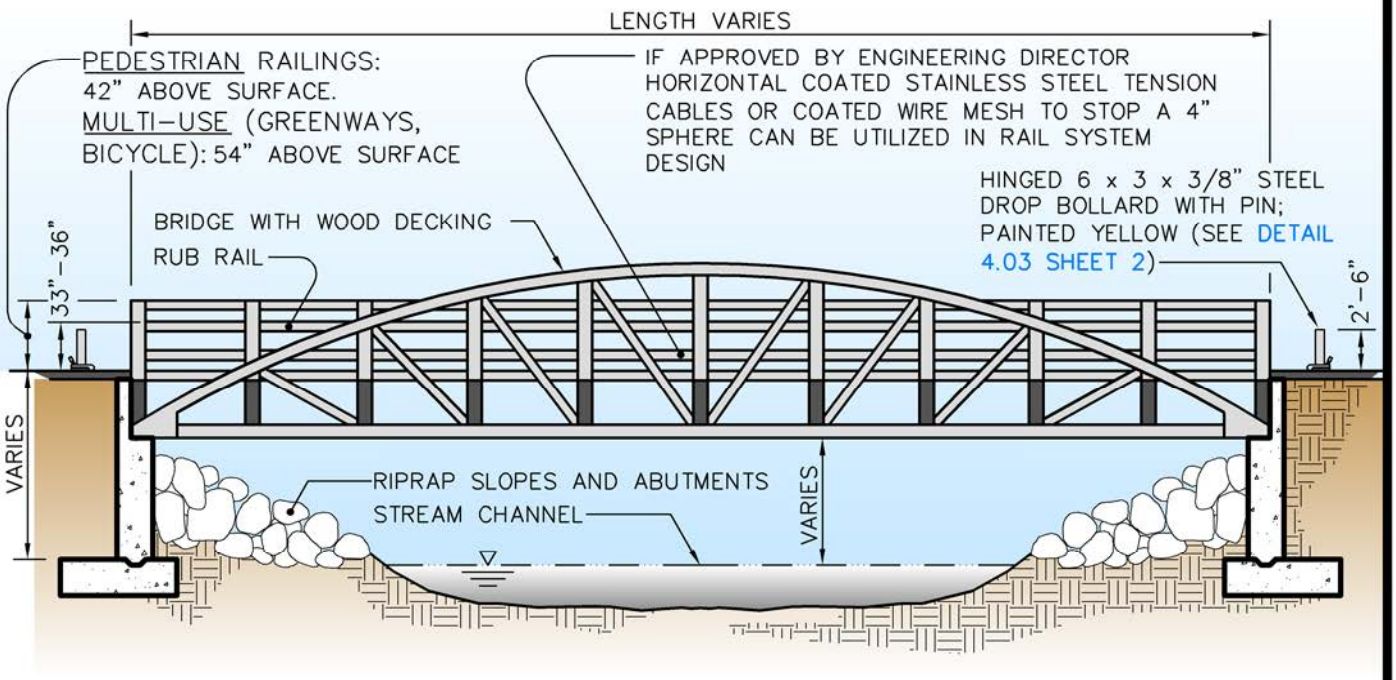
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2. When height of boardwalk exceeds 30", designer to evaluate need for lateral bracing.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

ALT. BOARDWALK / FOOT BRIDGE FOUNDATION SYSTEM OPTION

SCALE:	DETAIL #
Not To Scale	24.08
REVISION DATE: July, 2023	SHEET #: 1 of 1



NOTES:

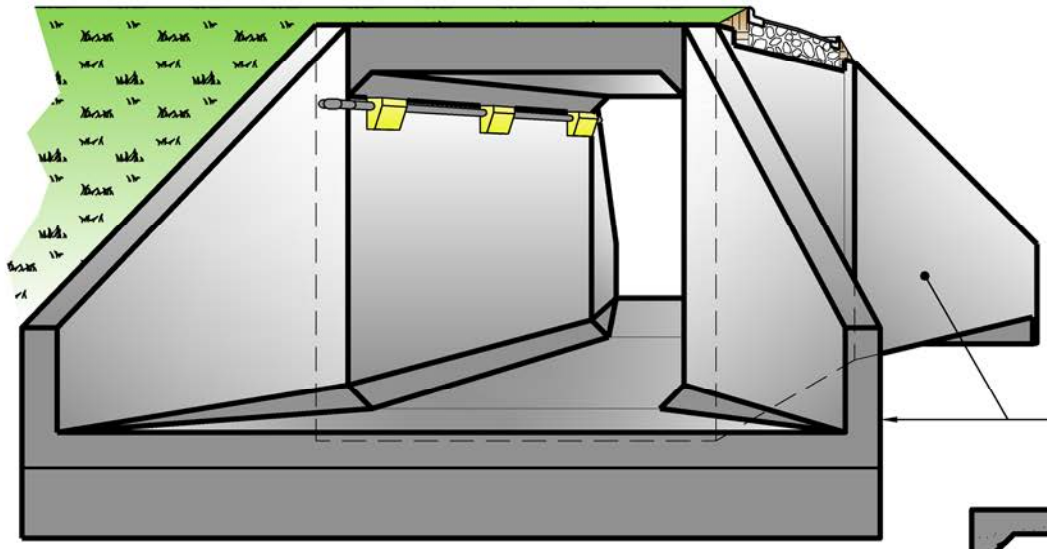
1. Refer to the Town of Clayton Boardwalk and Foot Bridge Design manual for design criteria.

TOWN of CLAYTON

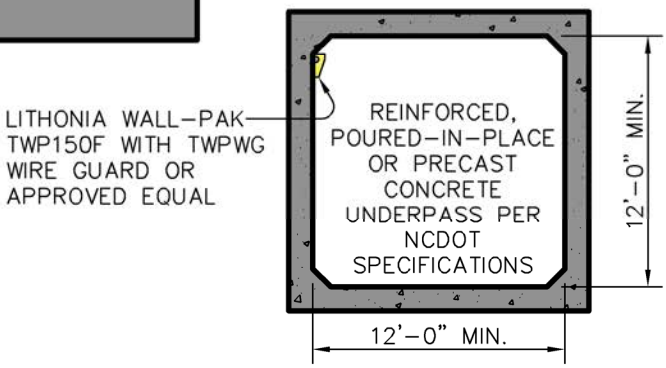
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

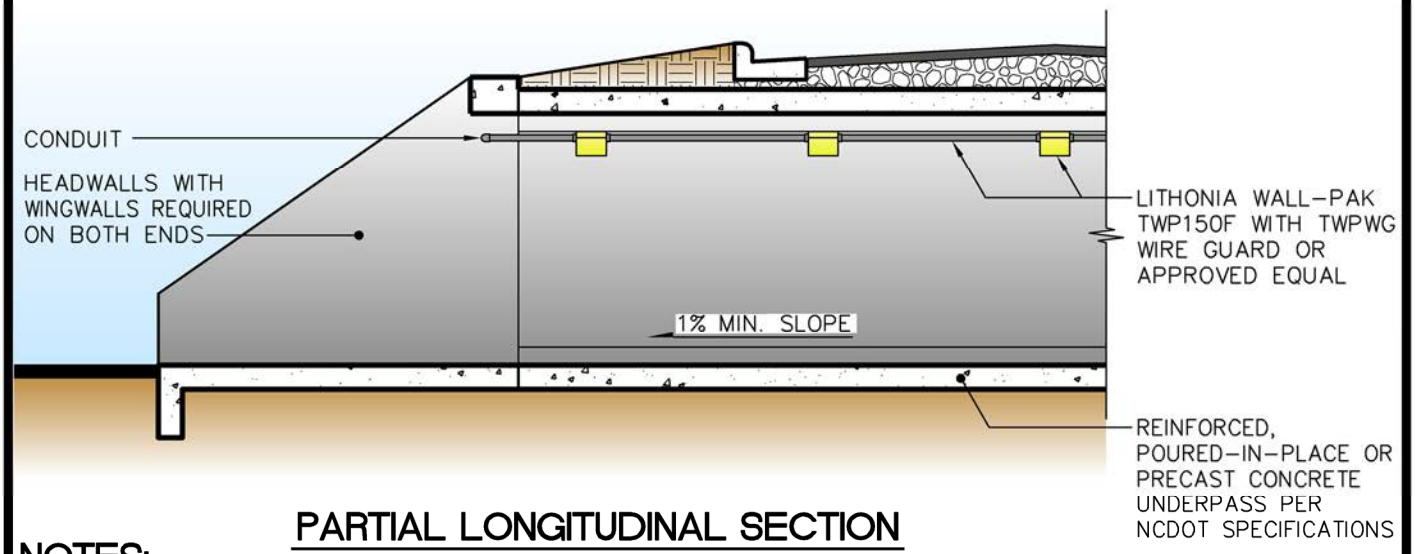
MULTI-USE PATH DETAIL BOWSTRING PRATT HALF THROUGH TRUSS OPTION

SCALE:	DETAIL #
Not To Scale	2 4.09
REVISION DATE: April, 2024	SHEET #: 1 of 1



FRONT VIEW
(ISOMETRIC)





PARTIAL LONGITUDINAL SECTION

NOTES:

1. Sealing of fixtures to be designed in accordance with IES standards
2. Appropriate signage to be placed at entrance to indicate narrowing trail width if applicable and limited vertical clearance.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PEDESTRIAN / BICYCLE UNDERPASS

SCALE:	DETAIL #
Not To Scale	24.10
REVISION DATE:	SHEET #:
July, 2023	1 of 1

STREET DESIGN

SELECTED LINKS TO SECTIONS WITHIN THIS DOCUMENT

Section 1 – Introduction
Section 2 – Street Design
Section 3 – Pavement Design
Section 4 – Subgrade Preparation & Testing
Section 5 – Bibliography
Concrete Testing
Design Speed
Horizonal & Vertical Street Standards
Inspections
Pavement Design Life
Pavement Markings
Proof rolling
Sight Distance
Street Name Signs
Traffic Signals
Warranty and Acceptance

SECTION 1
INTRODUCTION – STREETS

(Last revised 9/12/24)

The following section has been established to assist Developers and Engineers with the design of streets and alleys (private and public) within the jurisdiction of the Town of Clayton. The information presented in this section are intended to establish minimal guidelines for residential and commercial pavement design. The following design criteria are sufficient to ensure the welfare and safety of the general public and to protect the economic investment of the citizens of our Town.

There should not be extensive variations from the design methods, criteria and procedures within this section without the expressed approval of the Engineering Director or their designee.

TOWN OF CLAYTON ENGINEERING DIRECTOR/STAFF

The Town of Clayton Engineering Director and/or Engineering staff shall be responsible for interpretation and implementation of the pavement design criteria for the Town of Clayton.

Approval from other applicable agencies may be required.

1.1 TOWN OF CLAYTON ACCEPTANCE POLICY

It is the policy of the Town of Clayton that all developed land within the Town Limits have adequate streets. The Town may accept roadway systems for maintenance if the system provides pavement sections that have been accepted for maintenance by the Town and have been designed and constructed in accordance with the provisions of the Town and this section.

1.2 PRIVATE STREETS

1. Private streets shall be permitted only for on-site access and circulation improvements in nonresidential, multi-family, and mixed-use developments.

2. The responsibility for maintaining private streets, as well as associated sidewalks and bicycle travel ways, shall be vested with either a property owner, homeowner, or management association.

3. Existing private streets wanting to convert to public streets must be brought up to current MSSD standards and are subject to the Private Street Acceptance Policy. Any requests for Private Street Acceptance must submit an application to the Engineering Director.

1.3 APPLICABLE STANDARDS

1. All streets and alleys, both private and public, shall be designed and constructed to Town of Clayton standards, as appropriate based on location.

2. Town of Clayton standards shall be applied to all streets anticipated to be maintained by the Town, to other streets (including private streets), and alleys to the extent they are required by the Unified Development Ordinance (UDO).

3. NCDOT Standards and Specifications shall be applied to all existing NCDOT maintained roads, extensions of NCDOT roads, or roads anticipated to be maintained by NCDOT unless the Town Standards are more restrictive.

SECTION 2
STREET DESIGN

All streets within the jurisdiction of the Town of Clayton shall meet all the requirements of this manual, the UDO and the most recent Comprehensive Transportation Plan (CTP). Designers are to refer to **Standard Detail 401.01** and the Town of Clayton UDO for requirements related to pavement width, curb and gutter, etc.

2.1 PAVEMENT AND RIGHT-OF-WAY WIDTH

Standard street widths are shown in the Standard Details. Actual street and right-of-way widths shall be in accordance with the CTP. The Engineering Director may, at his/her discretion, require additional widening or related work as deemed necessary to provide for the safety and quality of roadways for the traveling public.

2.2 DESIGN SPEED

1. The design speed chosen for a particular street will be determined based on street classification in the CTP, adjacent land uses, and topography.

2. Design speed shall be at least 40 MPH on all streets leading from a roadway with a posted speed limit of 55 MPH or higher for at least the first ¼ mile.

3. Design speed shall be no less than 5 MPH more than the intended posted speed limit, unless otherwise required by the Engineering Director.

2.3 HORIZONTAL AND VERTICAL ALIGNMENT STANDARDS

Table 2.3: Horizontal and Vertical Curve Design Controls

Street Classification (CTP)		Design Speed (mph)	Design Vehicle	Horizontal Curve Design				Vertical Curve Design			
				Minimum Centerline Radius (ft)	Minimum Curb Radius (ft)	Minimum Tangent between Reverse Curves (ft)	Maximum Superelevation (ft/ft)	Minimum K Value		Maximum Grade (%)**	Minimum Curve Length (ft)***
								Crest	Sag		
Alleys	Residential	<10	SU-30	75	20	50	Reverse Crown	12	26	8	50
Local Road	Residential	30	WB-40	150	20	50	Normal Crown	12	26	8	100
Minor Collector	All	30-40	WB-40	375	30	200	.04	30	50	8	100
Major Collector	All	30-50	WB-40	375	30	200	.04	30	50	8	100
Industrial	Industrial	30-40	WB-62	375	30	200	.04	29	49	8	100
Minor Arterial	All	30-50	WB-62	535	40	250	.04	44	64	8	125

Notes:
mph = mile per hour; ft = feet
** Maximum vertical grade >8% may be approve based on exceptional topography at the discretion of the Engineering Director.
*** All vertical curves shall be symmetrical parabolic curves.

2.4 GRADES

1. The grade on any Town of Clayton street shall not be less than (1%) unless otherwise approved by the Engineering Director.

2. At intersections not controlled by a traffic signal, the grade shall not exceed five (5%) percent for a distance of at least one hundred (100) feet measured from the centerline of the intersecting street. Intersections shall be labeled on all vertical profile sheets.

3. At signalized intersections, the maximum grade approaching the intersection should not exceed two (2%) percent and extend a minimum of 200 feet in each direction measured from the outside edge of travel way of the intersecting street.

4. Commercial and Industrial driveways or entrance roads tying to a public roadway facility accessible to emergency fire apparatus: Approach grades shall not exceed 8% or as otherwise allowed or permitted by the Fire Marshall. See NC Fire Code Sections D102 and D103 of Appendix D, Fire Apparatus Access Road. K values shall be as directed by either the Engineering Director or Fire Marshall but at a minimum shall be sufficient to prevent front or rear bumper drag.

2.5 ROADWAY TAPERS

1. Turn Lanes may be required to be constructed along existing roadways for new streets and driveways. If road widening is required to accommodate a new turn lane, the equations in **Table 2.5**, right, shall be used to calculate the appropriate taper lengths based on offset and design speed of the existing street.

Table 2.5
Taper Lengths for Turn Lanes

Speed	Formula
Less than 40 mph	$L = WS^2/60$
45 mph and greater	$L = WS$

Notes:
mph = mile per hour; ft = feet
L = Length of taper (ft)
W = Width of offset (ft)
S = Roadway design speed (mph)

2. When a new street being constructed will directly connect to an existing street of a different width, it may be necessary to install a transition taper between the two. The length of the taper is dependent upon the offset between the two outside edges of pavement and design speed. The equations for calculating the appropriate taper length are shown in **Table 2.5**, above.

2.6 GRADING

Grading and filling shall be undertaken to ensure that:

1. The street is centered in the right-of-way.

2. Adequate shoulders and space for future sidewalks (if not being installed) are provided.

3. Allowance is made for roadside ditches, curbs and gutters, and storm drainage pipe for street drainage.

4. Cut slopes shall not exceed a ratio of 4:1

5. Fill slopes shall not exceed a ratio of 4:1

6. Ditch front slopes do not exceed a ratio of 4:1 for shoulder sections.

7. See **Standard Detail 401.01**.

2.7 CUL-DE-SAC DESIGN

1. Minimum dimensions for circular cul-de-sac streets are shown in the **Standard Detail 401.02**. Cul de sacs are to accommodate a fire apparatus in accordance with Appendix D of the NC State Building Code: Fire Prevention Code, latest edition.

2. Cul-de-sac design can include medians where the radius is increased if it can be demonstrated that emergency vehicles and Town of Clayton Sanitation vehicles can be

accommodated. The Town of Clayton will not maintain any landscaped medians. An Encroachment Agreement may be required for anything placed inside the median

3. Refer to UDO for cul-de-sac street length requirements.

4. Hammerheads shall be installed temporarily, in-lieu of cul-de-sacs, at locations where roadways can be extended in the future through an adjacent property. See **Standard Detail 401.02, sheet 2**.

5. Parking and Driveway access is prohibited from being located in a hammerhead, unless for utility and emergency services access.

2.8 INTERSECTION DESIGN

1. Streets should intersect at angles as close to 90 degrees as possible and shall not be designed at any angle less than 75 degrees, unless a roundabout is proposed.

2. No more than two (2) streets shall intersect at any one point, unless the intersection is designed as a roundabout.

3. Curb radii shall be designed to accommodate the design vehicle for that roadway as listed in Table 2.3. No residential curb radii shall be less than 20 feet.

4. Street jogs with centerline offsets of less than 125 feet are prohibited.

5. Intersections and driveways shall be spaced as stated in the UDO.

6. All proposed connections to existing NCDOT roadways shall meet the criteria of the latest revisions of the NCDOT "*Policy on Street and Driveway Access to North Carolina Highways*," latest revision.

7. Sight distance shall be provided in accordance with Section 2.9 and **Standard Detail 403.01**.

8. Median breaks on divided roadways for driveway access may only be approved if a minimum of 1,100 feet spacing exists between the nearest intersection, median break, or proposed intersection. Median breaks are subject to the approval by the Engineering Director. A median break is not guaranteed.

9. See **Standard Detail 401.02** for typical Cul-De-Sac detail.

2.9 INTERSECTION SIGHT DISTANCE

1. All intersection sight distance shall comply with the latest version of AASHTO's *Policy on Geometric Design of Highways and Streets* manual and/or NCDOT standards, as applicable.

2. Intersection sight distance is based on conflicts with opposing vehicles.

3. The amount of intersection sight distance is controlled by the type of traffic control device at the intersection and the speed vehicle approach the intersection.

4. Intersection sight distance is measured from the driver's decision point, 3.5 feet (height of driver's eye) above the roadway to allow drivers an unobstructed line of sight to the roadway

they wish to enter or cross.

5. If sight distance cannot be achieved due to limitations, approval of the intersection may not be granted by the Engineering Director. In such cases, other alternatives (e.g. reduced posted speed limit, warning signs, traffic signals, or other traffic control) may be proposed. All alternatives are subject to the approval of the Engineering Director.

6. At all intersections to both Town and NCDOT streets, a minimum of a 10-foot by 70-foot sight distance triangle easement shall be dedicated on the recorded plat to restrict the use of this area from obstructing the line of site at that intersection. No object greater than 30" in height can be placed or constructed in this area. See **Standard Detail 403.01**.

7. If the required sight distance area, to comply with AASHTO and NCDOT, exceeds the 10-foot by 70-foot sight distance triangle footprint, additional sight distance easement may be required to be dedicated.

2.10 INSTALLATION OF UTILITIES, STORM DRAINAGE, AND STREET LIGHTS

1. Prior to final subgrade grading, and prior to placement of stone base, all underground utilities (e.g., storm drainage, water mains, sewer mains, taps, etc.) must be installed, tested, and approved by the Engineering Director in accordance with applicable requirements of the respective specification sections.

2. Where conduit for irrigation or street lighting will be necessary or required, the conduit or service drops are to be trenched, properly backfilled, and compacted. After paving is complete, such service drops shall be directionally bored.

3. No taps or pavement cuts shall occur in the final surface of asphalt.

2.11 DRAINAGE

1. Inlet design and spacing to be designed in accordance with the Storm Drainage Design Manual.

2. Streets shall be planned and designed in such a way that storm runoff does not cross intersections. Storm drainage structures should be used to avoid storm runoff crossing intersections. Directional arrows must be shown on plans to reflect surface drainage flow. This is particularly important around curb returns.

3. Under no circumstances will penetration of the back of the curb and gutter be permitted (i.e. "cutdowns" for drainage or small pipes) for drainage.

4. On paved streets without curb and gutter, the absolute minimum shall consist of shoulders graded to allow water to run off the street and collect in such a manner that it will not return in the subsurface to the base of the street. When soil conditions permit and the property owner desires, roadside drainage may consist of water ponding off the strip paved street until it is absorbed in the ground if, in the opinion of the Engineering Director said ponding will not adversely affect the life of the street.

5. In all subdivisions where there is no curb and gutter, side ditches which require protection for erosion caused by excessive velocity shall be concrete paved. Riprap may be accepted upon

approval of Town of Clayton's Engineering Director.

6. Width for shoulder/swale section where appropriate is shown in the Standard Details. No on-street parking would be permissible for this cross section. This design would only be appropriate for low-density development or within a watershed protection area.

2.12 STREET SECTIONS

1. **Curb and Gutter**

   a. Standard Curb and Gutter shall be required on all streets unless otherwise stated in UDO.

   b. All curb and gutter shall be constructed according to the appropriate standard details.

   c. Standard 30" curb and gutter, roll type curb and gutter, and 18" median curb is required to be used on all Town of Clayton public streets. See **Standard Details 401.01** and **402.01**.

   d. Valley curb is PROHIBITED in any development unless the development is located in a critical watershed area with surface water requirements, subject to approval by the Engineering Director Staff.

   e. In developments where driveway spacing does not allow for adequate transition for standard curb, valley curb may be requested to Engineering Director. Approval for valley curb is not guaranteed.

2.13 SIDEWALKS & MULTI-USE PATHS

Sidewalk & Multi-Use Path (MUP) material, width and locations shall be in accordance with the Town's Unified Development Ordinance.

No concrete shall be placed until the forms, necessary conduits, and subgrades have been inspected and approved by Town of Clayton inspector.

1. **Curb Cuts and Curb Ramps:** Curb cuts and curb ramps, commonly used to provide accessibility for persons with disabilities, shall be provided at all intersections where curb and gutter is provided and where sidewalks and/or greenway trails intersect streets subject to the following conditions:

   a. Where sidewalk is not required, the curb return shall be depressed to the specified dimensions for the future connection of curb ramps.

   b. Sidewalk construction shall meet the applicable provisions of the latest editions of ANSI A117.1, the NC State Building Code, and the 2010 Standards for State and Local Government Facilities: Title II.

   c. See the Town of Clayton Standard Details for other requirements pertaining to curb ramp construction.

2.14 CONSTRUCTION METHODS FOR BRICK SIDEWALKS

1. **Subgrade Preparation**: The subgrade for sidewalks shall be shaped to the proper cross-section and thoroughly compacted by rolling or tamping. Tree roots shall be removed to a

depth of 12-inches below subgrade for the full width of the walk. All soft and spongy material shall be removed and replaced with suitable material that shall be compacted in layers not exceeding 6-inches in thickness.

2. **Base**: A 5-inch thick base of stone screenings or sand, well compacted and properly graded to provide drainage according to the standard sidewalk slope, shall be installed. Where the sidewalk is crossed by a driveway, the base shall be increased to 6-inches.

3. **Width & Material**: Except when repairing a non-conforming brick sidewalk, a 5-foot wide sidewalk of paving brick (conforming to ASTM C902) shall be laid to grade with a smooth uniform surface with a slope of ¼-inch per foot toward the street.

4. **Filling Voids of Brick Walks**: The voids between the brick shall be filled with a mixture of sand and cement broomed into the voids. The sand-cement ratio shall be 1/3 cement and 2/3 sand well mixed before brooming into the voids. After the voids are well filled, the brick surface shall be cleaned of all excess sand and cement.

2.15 MATERIALS TESTING

1. **Asphalt, Concrete and Subgrade Testing:** Refer to Section 4.1, **Subgrade Preparation & Testing**.

2.16 TRAFFIC CALMING

1. The Engineering Director, at his/her discretion, may require the use of traffic calming measures within the street design to minimize negative impacts that may arise in residential areas. These measures are intended to reduce vehicular speed, improve safety for drivers and pedestrians, or reduce traffic enforcement.

2. Speed bumps, speed humps, and speed tables are prohibited on Town of Clayton streets.

2.17 PAVEMENT MARKINGS

1. All new streets, both public and private, are required to have pavement markings.

2. Pavement Markings shall be designed in accordance with the latest MUTCD standards.

3. A separate Pavement Marking and Signage plan shall be submitted during Construction Drawings approval.

4. All pavement markings shall be Thermoplastic and installed in accordance with MUTCD and the applicable Standard Details.

2.18 TRAFFIC CONTROL SIGNAGE

1. **Design and Installation**:

   a. All streets, both private and public, are required to have traffic control signage.

   b. All signage and traffic control shall be designed with the latest MUTCD standards.

c. Signage and traffic control shall be installed per **Standard Details 403.06** and **407.08**, and the latest revision of the MUTCD, as applicable.

d. All signage shall be installed using a standard hot-dipped galvanized steel U-channel posts. Decorative sign posts may be approved on a case-by-case basis by the Engineering Director.

e. The developer is responsible for all costs related to the purchase and installation of traffic control signs.

2. **Decorative Sign Posts**:

a. A developer or HOA may submit a request to the Engineering Director for the use of decorative posts.

b. All decorative posts shall be designed as "break-away and still meet the applicable requirements of **Standard Detail 407.08**.

c. The developer or HOA would be solely responsible for the installation, maintenance, and/or replacement costs associated with the decorative posts.

d. If the decorative posts become unavailable for replacement, the developer or HOA would be responsible for the costs related to change out the posts.

e. The Town may, at any time, decide to remove the decorative posts without notice if a safety issue arises.

f. Stop signs on Decorative Posts: The Town will replace a stop sign if one falls down, replacing the post with a Town of Clayton Standard U-Channel steel post. However, when the HOA replaces the steel post with a decorative post, the Town's U-Channel post is to be returned to the Town.

2.19 STREET NAME SIGNS

1. Street name signs shall be installed on at all intersections prior to issuance of any Certificate of Occupancy.

2. The Developer or HOA is responsible for all costs related to the purchase and installation of traffic control signs

3. Proposed street names shall be submitted and are subject to approval by the Town of Clayton and Johnston County, as applicable. New street names shall not duplicate or be similar to existing street names. Existing street names shall be used when extending an existing street.

4. Street name signs shall have a minimum service life of ten (10) years.

5. **Design and Installation:**

a. All street name signs shall be designed per the latest MUTCD standards

b. All street name signs shall be installed per **Standard Detail 407.08**.

c. Refer to **Standard Detail 407.08** decorative sign post information

d. All signs shall be fabricated from High Intensity Prismatic Grade Reflective Green Sheeting and meet USDOT FHA ASTM Type III standards. For major arterials, fabricate from Diamond Grade reflective sheeting.

e. A square metal post with identical sign blades affixed at the center of the post shall be utilized at all applications. Street name signs shall be fastened together on both ends.

f. Blades shall be 9 inches in height. Length shall be proportionate to the height and road name.

g. All text shall utilize only capital letters in standard Highway Gothic font or approved equal. Deviations from this require approval from the Engineering Director.

h. Blades shall be white with green overlay.

i. Lettering color shall be white.

j. Street name text shall be six (6) inches in height.

k. Supplemental text shall be three (3) inches in height.

l. Private street designation shall be properly labeled on the left side of the sign blade as “PRIVATE” in a yellow reflective background with 3-inch black letters.

m. Where a new street intersects a NCDOT Roadway, the sign blade shall be properly labeled with the SR # on the left side of the sign blade.

n. Block information shall be provided on the bottom right of the street blade

2.20 TRAFFIC SIGNALS

1. GENERAL

a. All design, installation, and construction, of traffic signals shall utilize the standards and specifications in the NCDOT’s Transportation Mobility and Safety Division, Signal Design Section’s “*Design Manual*,” latest revision.

2. POLE MATERIAL

a. Unless deviations are approved otherwise by the Engineering Director, metal mast-arm poles shall be used in all locations.

b. Wood poles may be approved in locations that are not widened to their final ultimate section at the discretion of the Engineering Director.

SECTION 3
PAVEMENT DESIGN

3.1 PAVEMENT DESIGN

The purpose of this section is to provide a guide for the design of pavement structures for the Town of Clayton.

1. **GENERAL**

   a. Pavement design is based on site-specific conditions and shall be submitted for all streets and alleys, both public and private.

   b. The proposed pavement design shall be signed and sealed by a Professional Engineer licensed in the state of North Carolina using AASHTO methodology.

   c. The pavement design shall be submitted during construction drawing approval.

   d. All streets to be maintained by NCDOT shall adhere to NCDOT pavement design specifications and be approved by the NCDOT.

   e. The pavement design report shall be based on both field and lab testing of subgrade materials by a qualified Geotechnical firm.

   f. The pavement design report shall be based on the following minimum criteria:

      1. A 20-year design life
      2. A 3% annual growth rate
      3. Appropriate traffic projections
      4. Unless the submitted pavement design calls for a thicker pavement section, the minimum pavement and base thickness, roadway geometric properties, and typical street sections shown on **Standard Detail 401.01** shall be used. The minimum CABC depth shall be 8 inches over a compacted subgrade.

SECTION 4
SUBGRADE PREPARATION & TESTING

4.1 SUBGRADE PREPARATION & TESTING

The purpose of this section is to provide a guide for the subgrade preparation of paved areas within the Town of Clayton.

4.1.1 SUBGRADE INSPECTION – CBR TESTING

1. If the soils at the site were tested to obtain the CBR and SSV, the soils below the proposed pavement subgrade must be compacted during construction to a density equal to or greater than the density at which the CBR test was performed. Unless filling is involved, the upper twelve (12) inches of soil below the proposed pavement section must be compacted.

2. After the subgrade has been brought to grade, the design assumptions shall be confirmed by visual inspection and classification of the subgrade soils by the Geotechnical Engineer that performed the original investigation. In-situ CBR's do not have to be taken to verify the design pavement section unless the exposed subgrade is deemed by the Geotechnical Engineer to be at variance with the original CBR's.

4.1.2 SUBGRADE INSPECTION – DENSITY TESTS

1. In the areas where the roadway has been filled (fill sections), the soil below the pavement section must have been placed in lifts, compacted, and verified by field density tests during fill placement to meet the minimum requirements outlined in Specification Section 02200, *Earthwork*. The test results shall be submitted to and approved by the Engineering Director prior to placement of stone base.

2. Field density tests do not have to be performed in either cut sections or undercut areas. Proof rolling shall be performed on these areas. However, if the undercut area is considered to be extensive, as determined by the Engineering Director, the Engineering Director may require that density tests be performed in those areas during placement of borrow/fill.

3. The subgrade in cut sections must be compacted prior to proof rolling.

4.1.3 SUBGRADE INSPECTION – PROOF ROLLING

1. No pavement shall be placed in the Town of Clayton without prior inspection and approval by the Town of Clayton Engineering Department. The inspection shall include, but not be limited to, proof rolling the prepared subgrade with a rubber-tired proof-roller (**fully loaded** dump truck) that has a minimum gross weight of at least 40,000 pounds (20 tons) under the observation of a representative of the Town. Leave the lift axles in up position to affectively yield a tandem axle proof roll. **No other method will be acceptable**.

   The developer shall bear the costs of proof rolling which must be done within ten (10) days prior to placement of the asphalt. All areas of the subgrade shall be covered by the wheels of the proof-roller operating at walking speed (two or three miles per hour).

2. The earthen subgrade must pass a proof roll prior to the placement of the stone base course or the concrete curb and gutter. The stone base course must in turn pass proof rolling prior to placement of asphalt on the stone base. Any subgrade that has been rained on or frozen after proof roll, but prior to being covered with base, **will be required to have another proof roll prior to placement of base**. At a minimum, visual inspection of stone base course following a precipitation event is required.

3. Any areas that rut, or pump excessively under the wheels of the proof-roller, as determined by the Engineering Director, shall be repaired by the developer before the street is paved. Those repaired areas, at the discretion of the Engineering Director, may be required to be proof rolled prior to placement of stone or asphalt, as applicable. Prior to placement of either stone base or asphalt, while exposed to weather, the Contractor shall exercise care and diligence in protecting and maintaining drainage of the subgrade in order to minimize the potential for subgrade deterioration.

4. The Town reserves the right to reject any subgrade (in-situ soil or embankment fill) that has not been approved, a subgrade that has been rained on, or a subgrade that is frozen after the previous inspection prior to being covered with fill or stone base.

5. Partial approvals of subgrade improvements will not be provided unless a visual means of station identification is clearly marked in the field along the street (or gridding for sites).

6. Should the Contractor or Developer disagree with the representative of the Town about the need for repairs to the subgrade, the Contractor, developer or his project engineer may employ a Licensed Professional Geotechnical Engineer to perform such tests as may be required to confirm the adequacy of the prepared subgrade with the test results provided to the Engineering Director for review and approval. If the Geotechnical Engineer certifies that the full width and length of the subgrade will provide adequate support for the design pavement section as prepared by the Contractor and the anticipated loading for the design life of the paved area, the area may be paved without making repairs to the subgrade. However, the Engineering Director reserves the right to request/require such additional tests as deemed necessary to satisfy himself/herself as to the adequacy of the subgrade.

7. All construction and testing of materials shall be in accordance with the Town of Clayton Manual of Specifications.

4.2 STREET INSPECTIONS & TESTING

4.2.1 MINIMUM INSPECTION CRITERIA

Minimum Inspections: The following shall be the minimum inspections required by the Town:

1. **Prior to Concrete Placement**: No concrete shall be placed until the forms, necessary conduits, and subgrades have been inspected and approved by Town of Clayton inspector.

2. **Proof roll Curb & Gutter:** No base course under curb and gutter except as required by the geotechnical report.

3. **Proof roll street subgrade:** If stone is used to help stabilize subgrade, the poof roll must be at subgrade elevation. See Section 4.1.3 above for proof rolling procedure.

4. **Crossfall (transverse grade) on subgrade** from crown to curb shall be checked with a string line prior to placement of base course.

5. **Base course** shall be proof rolled just prior to placement of asphalt. Crossfall on base course, from crown to curb, shall be checked with a string line prior to placement of asphalt. Quarter points in particular shall be checked.

6. Cracked curb sections are to be removed and replaced prior to paving.

7. **Paving lifts**: If the proposed asphalt layer depth exceeds the maximum single lift thickness shown in Table 4.2.1 below, asphalt must be placed in **two lifts**; the first lift having a thickness of not less than the minimum single lift depth shown in Table 4.2.1, below. The maximum layer depth, shown in Table 4.2.1 below shall not be exceeded. Asphalt cores must be taken to confirm thickness and compaction. See Section 4.3, *Testing*, below.

Table 4.2.1 Recommended Pavement Thickness Chart

Mix Type	*Minimum Single Lift Depth (inches)*[aa]	*Maximum Single Lift (inches)*	*Maximum Layer Depth (inches)*
SA-1	0.5	1	2
S4.75A	0.75	1	2
S9.5B[a]	1.0[b]	1.5	3
S9.5C, D	1.5	2	3
I19.0C	2.5	4	4
B25.0C	3[c]	5.5	---
ABC[d]	4	10[e]	No Restrictions

Source: NCDOT 2024 Asphalt Quality Management System, HMA QMS Manual, Table 3.3

[aa]Approximate Minimum Thicknesses; lower rates bay be used for leveling courses
[a]X= Level of Service.
[b]For S9.5B placed on top of an Asphalt Surface Treatment (AST) MAT coat, minimum lift thickness is 1.5 inches.
[c]For **B 25.0X** placed on unstabilized subgrade, minimum lift thickness is 4.0 inches.
[d]Construct the base so that the thickness of the base is within a tolerance of plus or minus ½ inch of the base thickness required by the plans.
[e]Where the required compacted thickness is more than 10 inches, spread the base material in 2 or more approximately equal layers. Compact the base material to a minimum thickness of approximately 4 inches for any one layer.

8. **Temperature** (Ambient Air and Mix): See NCDOT *Standard Specifications for Roads & Structures*, latest edition for asphalt temperature requirements; Section 610-4 *Weather, Temperature and Seasonal Limitations for Producing and Placing Asphalt Mixtures* and Table 610-6, *Placement Temperatures for Asphalt*. For concrete, see Section 02400 – Curb & Gutter, Sidewalks, & Driveways, paragraph 3.1.6 B, Cold Weather Concreting.

9. **Sidewalk** forms and subgrade shall be checked prior to pouring. Slump and strength tests shall be required. See Section 4.3, *Testing*, below.

10. All **driveway** forms must be checked prior to pouring. If a ditch and shoulder section is used, culvert inverts must be checked.

11. **Driveway culverts** must be installed to ensure positive and uniform ditch flow line grade between publicly maintained structures/culverts.

12. **Grade and Alignment**: The Town shall not be responsible for ensuring proper grade and alignment.

4.2.2 CO Inspections

Before a Certificate of Occupancy will be granted, the following shall be the minimum inspections required by the Town:

1. Broken Curb & Gutter along frontage where applicable.
2. Broken Sidewalk where applicable.
3. Broken driveway aprons where applicable.
4. Water meter box set per **Standard Detail 519.01** and **519.03,** .
5. Sewer cleanout set per **Standard Detail 533.01**.
6. Grade right-of-way per the applicable section as shown in **Standard Detail 401.01**.
7. All temporary Erosion Control Measures have been removed.
8. Adequate ground cover has been established per approval by the Town of Clayton Engineering Department.

4.2.3 Geotechnical Engineering Inspection Services:

1. The services of a Geotechnical Engineer shall be required in all cases where unusual soil conditions have been found during construction such as high water table or springs, soft or yielding soils, unsuitable soils, or
2. A developer may elect to use the services of a consulting Geotechnical Engineer to perform all inspections of streets. In this case, the Geotechnical Engineer shall be required to guarantee that the street shall perform as required.
3. See also paragraphs 4.1.2 Subgrade Inspection - Density Tests and 4.1.3, Subgrade inspection – Proof Rolling, as applicable.

4.2.4 Inspection Fee: All inspections, which fail, are subject to a re-inspection fee.

4.2.5 Inspection Procedure: Warranty, maintenance during warranty period, inspection procedure, repairs, utility cuts, etc. are covered under Section 4.4, Warranty & Acceptance.

4.3 TESTING

4.3.1 Concrete Testing

1. See paragraph 3.1.8 *Testing* of Specification Section 02400 *Curb & Gutter, Driveways, and Sidewalks* for concrete testing requirements.

4.3.2 Asphalt Testing

1. **Compaction**: Testing for asphalt density is to follow NCDOT "Standard Specifications for Roads and Structures," Section 609-7, *Field Compaction Quality Control*, latest revision.

2. **Thickness**: The minimum frequency of coring for thickness testing shall be on the basis of test sections consisting of not more than 1,500 linear feet of lay down width, exclusive of intersections and irregular areas. The test sample is to be a 6-inch diameter cored sample. The sample is to be numbered and logged for identification purposes.

3. **Contractor's Quality Control System**: Follow NCDOT *Standard Specifications for Roads and Structures* Section 609-4 *Contractor's Quality Control System Personnel Requirements* and 609-5 *Contractor's Quality Control System Field Laboratory Requirements*, latest revisions.

4. **Mixture and Job Mix Formula Adjustments**: Follow NCDOT Standard Specifications for Roads and Structures, Section 609-6, *Plant Mix Quality Control*, latest revision.

5. **Asphalt Pavement Density Requirements**: See Section 02400 *Base Course and Paving* paragraph 3.6.3.G *Asphalt Pavement Density Requirements*.

6. **General**: All other applicable sections of Section 609 of the NCDOT *Standard Specifications for Road and Structures* shall apply relating to Quality Control Plan, mix design, control limits, corrective action, equipment and measurement.

7. **Testing Cost**: The cost of Quality Control (QC) tests, tests to assure the Contractor that he/she is meeting and complying with the requirements of these specifications, is the Contractor's responsibility. The cost of Quality Assurance (QA) tests, tests performed independently by the Town of Clayton to confirm that the Contractor is generally performing his/her work in compliance with these specifications, is the responsibility of the Town of Clayton.

4.3.3 SETUP PERIOD

1. Unless otherwise waived by the Engineering Director, for all new areas to be paved, the developer shall be required to wait at least six (6) months before the final lift of asphalt is placed. This setup period includes the winter months through February.

2. Existing streets that are to be rebuilt or reconstructed will not be required to meet this setup period and may be paved when the specifications in this manual are met and approved.

4.3.4 MAINTENANCE

For warranty, maintenance during warranty period, inspection procedure, repairs, utility cuts, etc. see Section 4.4, **Warranty & Acceptance**, below.

4.3.5 WARRANTY

Warranty, maintenance during warranty period, inspection procedure, repairs, utility cuts, etc. are covered under Section 4.4, **Warranty & Acceptance**, below.

4.4 WARRANTY & ACCEPTANCE

4.4.1 GENERAL REQUIREMENTS

1. Prior to commencing construction, all approvals including plan approval and all permits and encroachments shall be obtained. Site grading **only** may be performed upon issuance of a grading permit from the Town of Clayton. All other construction must await the issuance of all remaining permits. A preconstruction conference must also be held prior to commencing **any** construction.

2. The developer is responsible for the maintenance and repair of streets for twelve (12) months after acceptance by the Town for warranty. At the end of twelve (12) months the Town of Clayton will accept permanent responsibility. If a significant failure occurs requiring extensive maintenance during the first year of service, the Engineering Director shall suspend the twelve-(12) month warranty until the failure is repaired to an acceptable condition.

3. The developer is responsible for the maintenance and repair of all paved areas other than streets.

4. No contractor shall permit mud or construction debris to accumulate in any paved street which is maintained or is proposed to be maintained by the Town of Clayton.

5. The final lift of asphalt cannot be laid until 80% of the phase has been developed.

4.4.2 INSPECTIONS

1. Upon completion of construction, the developer shall request a final inspection. Upon completion of all punch list items, the provision of a set of acceptable record drawings, and the submission of engineer's certifications, a one-year warranty period shall commence.

2. During the one-year warranty period the developer shall promptly repair any latent defects which occur. At the end of the one-year warranty period, the developer shall request a warranty inspection. Upon successful completion of all warranty items the developer shall be released from maintenance responsibilities for the warranted construction.

3. All inspections must be scheduled the day prior to when needed. Inspections will be performed in the order received. Every effort will be made to accommodate the time of request; however, this cannot be guaranteed.

4. **All inspections, which fail, are subject to a re-inspection fee**.

4.4.3 MAINTENANCE

1. **Existing Streets:** The Town will assume all maintenance responsibility on all existing paved streets. If an individual owner wishes to pipe an existing roadside ditch and/or install curb and gutter in front of their property, the Engineering Director shall make a determination whether it is favorable to do so. The Town will, at its option install these improvements. If the Town installs these improvements, it shall require the owner to pay the full cost of the materials. The Town will cover labor and equipment cost.

2. **Existing Strip Paved Streets:** The Town shall maintain existing strip-paved streets in the following manner:

    a. Streets that have an adequate base and inadequate roadside drainage system shall be

resurfaced as required. This maintenance shall be at the sole cost and expense of the Town.

b. Streets that have an inadequate base, but an adequate roadside drainage system shall have the inadequate base replaced and shall be resurfaced as required. If in the judgment of the Engineering Director, more than one-half of the street surface needs its base replaced, the Engineering Director may recommend that the street be rebuilt with curb, gutter, and paving to standard Town of Clayton specifications. The Town Council will make the final determination as to whether the street is to be rebuilt with curb and gutter.
c. Streets that have inadequate base and/or inadequate roadside drainage will be resurfaced and drained as required. If, in the judgment of the Engineering Director, one-half of the street surface needs its base replaced or if adequate roadside drainage cannot be obtained without extensive work, the Engineering Director may recommend that the street be rebuilt with curb, butter and paving to standard Town specifications.

d. If a new roadside ditch is required and its invert elevation is more than 30" below the elevation of the edge of the finished asphalt surface, the resident may:

    1. Elect to have the ditch remain open, or

    2. Elect to have the ditch piped with the total cost of the piping and appurtenances being assessed against the property in a manner consistent with other street improvement assessments, or

    3. Elect to have curb and gutter and pavement widening installed in accordance with existing assessment policies.

    The Town Council will make the final determination for which option best meets the interest of the Town and parties involved.

e. Streets that intersect streets that have been petitioned for curb and gutter that also need curb and gutter to adequately drain into the street to be improved shall:

    1. Have curb and gutter installed upon recommendation of the Town's Engineer and upon approval of the Town Council.

3. **Existing Curb & Gutter Streets**: All existing public streets that have curb, gutter and paving shall be maintained as required at the sole cost and expense of the Town unless they are on the NCDOT system.

4. **Existing Dirt Streets**

a. All dirt streets are to be improved at the expense of the abutting property owners or developer. These improvements can be caused by petition, Town Council order or as a requirement to obtain subdivision approval. Once approved, the Town will thereafter maintain the street at its sole cost and expense.

b. Existing dirt streets accepted by the Town prior to adoption of this policy shall be maintained as a dirt street at the sole expense of the Town.

4.4.4 UTILITY CUTS

A permit will be required for any utility company wishing to excavate or place utilities in the Town of Clayton right-of-way. Pavement cuts in streets made by the utility company or the Town shall be repaired in either the following ways:

1. Compacted backfill shall be placed to within 15 inches of the top of the existing pavement surface after which 12-inches of ABC and 3-inches of S9.5B asphalt is to be placed. All edges shall be over-excavated by 12-inches on each side of the cut for placement of 12 inches minimum of new compacted ABC. After placement of the newly compacted 12-inch ABC base, over excavate the stone base an additional width of 12 inches on each side for placement of a minimum of 3 inches of compacted S9.5B asphalt. All pavement joints shall be tacked and sealed with an approved sealer. See **Standard Detail C01.03**.

   Refer also to Specification Section 02275 *Trenching, Backfilling and Compaction of Utilities* for specific utility trench width requirements, pipe cover requirements by utility type, and their associated referenced Standard Details.

2. Alternatively, the Contractor may backfill the cut with flowable fill concrete to within a minimum of 2 inches of the pavement surface (or match existing asphalt depth if greater than 2 inches in thickness) and top with a minimum of 2 inches of S 9.5B asphalt (or match existing thickness if greater than 2 inches). Excavatable flowable fill shall have a compressive strength of no less than 30 psi and no more than 100 psi. See Specification Section 02275, *Trenching, Backfilling, and Compaction of Utilities*, paragraph 2.1.1 for more information relating to flowable fill concrete.

3. Electric service shall not be installed until the street section is graded at final and approved.

4.4.5 USE OF EASEMENTS – HARD IMPROVEMENTS

All public easements including sewer, water, storm sewer and electric are to remain clear of obstructions. No buildings, fences, walls, signage, patios, decks, secondary structures, trees, shrubs or other obstructions shall be placed in any easement. Parking lots, walkways. driveways, and vehicular accessways may be located within any type of easement provided the purpose and function of the easement are not interrupted and provided the Town may access utility features, such as valves or manholes, at all times. Fences may be allowed transversely but not longitudinally across utility easement with an approved encroachment permit. Fences across utility easements shall be required to provide a 12-foot vehicular gate.

In the event landscaping or other structure located within a public easement must be removed in order to gain access or conduct maintenance, the Town may remove such features at the owner's expense and shall not be required to replace any removed landscaping or other structures located within a designated public easement.

In the event the removed landscaping or other required feature is required by this Ordinance, then it shall be re-established by the landowner promptly after removal by the Town.

The Town reserves the right to remove such asphalt, concrete, base course and sod as necessary to access its facility in the case of emergency. Pavement or concrete will be replaced with a patch. Sod will be replaced with fescue or rye seeding. The Town will not be responsible for replacing a property owner's sod after repairing a utility line.

SECTION 5
BIBLIOGRAPHY

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2. *Munispec* ©2011, Appian Consulting Engineers, PA, latest revision.

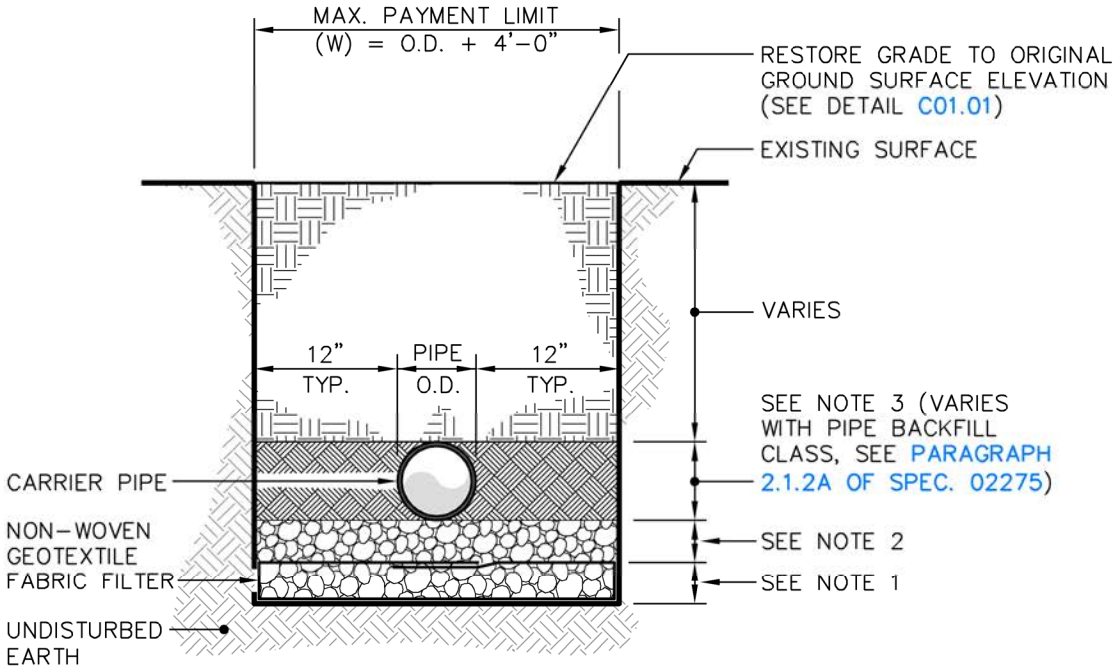
3. NCDOT Materials and Tests Unit, *Asphalt QMS Manual*, 2022 Asphalt Quality Management System.

4. NCDOT *Standard Specifications for Roads and Structures*, January 2024 and NCDOT 2024 *Roadway Standard Drawings*.

5. Transportation Research Board, National Cooperative Highway Research Program (NCHRP).

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NOTES:

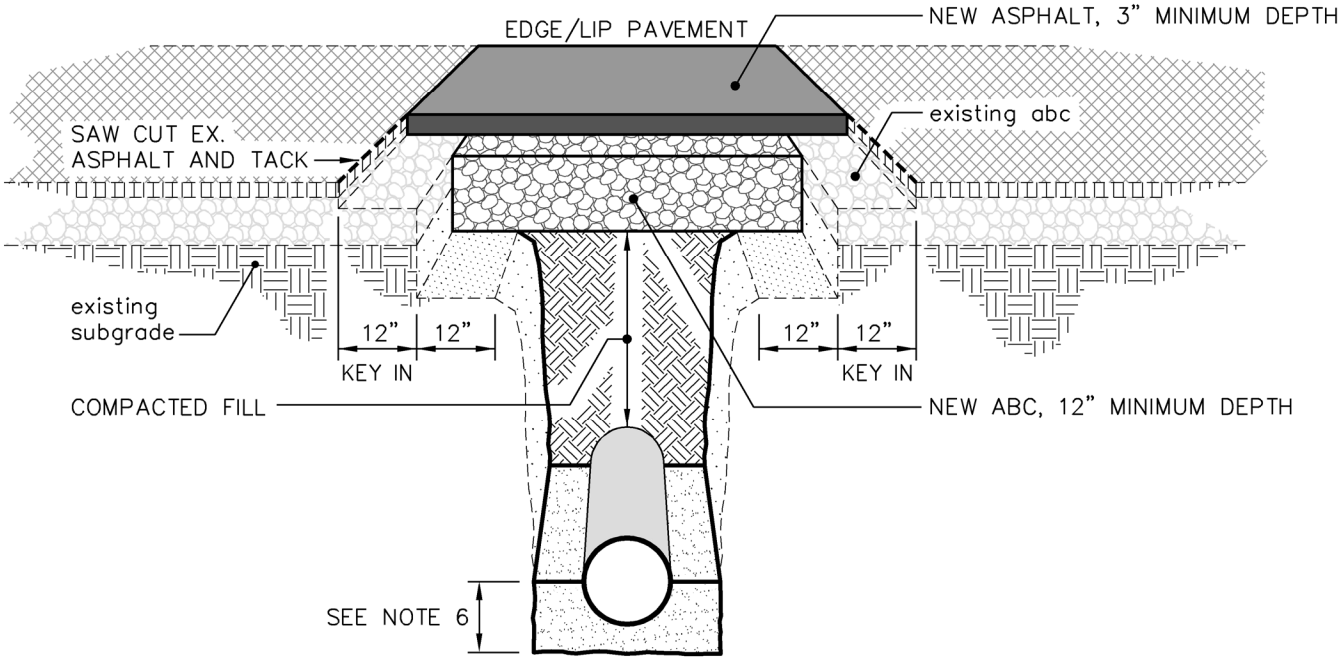
1. 8" deep No. 57 stone or equal wrapped in non-woven geotextile filter fabric lightly compacted. Overlap fabric by minimum one pipe O.D.
2. 4" deep No. 57 stone or equal lightly compacted pipe bedding.
3. General backfill compacted to 90% Standard Proctor density in 6" maximum lifts.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

UNSUITABLE SUBGRADE TRENCH DETAIL TYPE A (SEWER & STORM DRAINAGE)

SCALE:	DETAIL #
Not To Scale	2 C01.02
REVISION DATE: July, 2010	SHEET #: 1 of 1



NOTES:

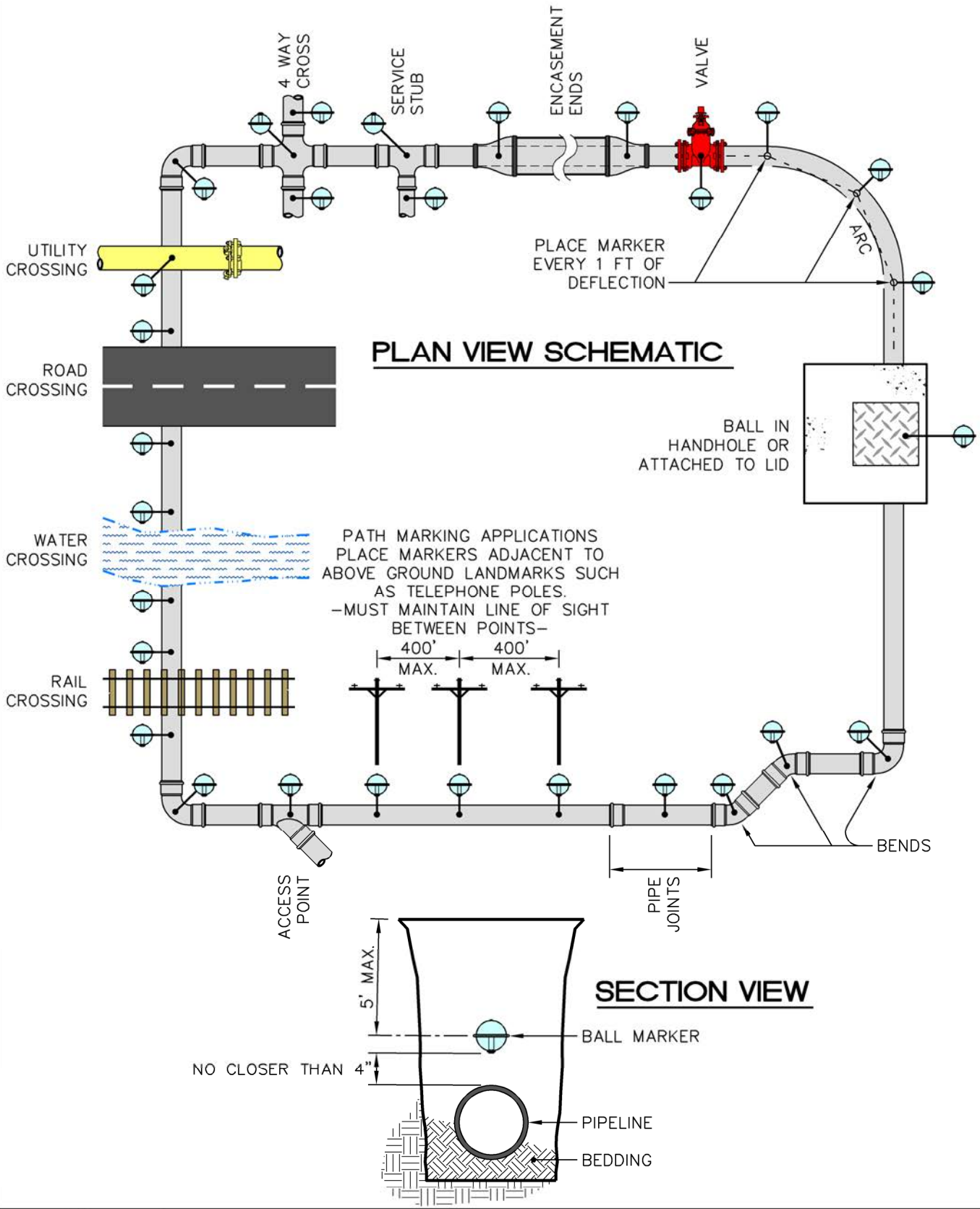
1. Trench is to be backfilled in 6" lifts with suitable material and compacted to a density of at least 95% as determined by AASHTO test method T–99.
2. The final 1' of fill shall consist of ABC material compacted to a density equal to 100% as determined by AASHTO test method T–180. Bituminous base or binder may be supplemented with the approval of the transportation engineer.
3. The entire existing depth of pavement shall be saw cut, clean of any debris, and tacked prior to paving.
4. The same depth of pavement material shall be reinstalled to match what exists. In no case shall the asphalt be less than 3" thick.
5. Patch shall be installed and compacted to provide a smooth and even transition.
6. For RCP 36" or greater, #57 washed stone shall be installed to the spring line prior to backfill
7. All density tests may be required to be performed in the presence of a Town Construction Inspector.
8. For small, non–compatible holes, flowable fill may be required.
9. All pavement shall be repaired within the same week it is cut.
10. See detail 511.01 for location of metallic tape and marker balls over nonferrous pipelines. See also detail C01.04.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PAVEMENT SURFACE REPAIR FOR UTILITY CUTS

SCALE:	DETAIL #
Not To Scale	2 C01.03
REVISION DATE: July, 2010	SHEET #: 1 of 1



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RFID FROM TOWN OF CLAYTON MARKER BALL LOCATIONS DIAGRAM

SCALE:	DETAIL #
Not To Scale	2 C01.04
REVISION DATE: July, 2010	SHEET #: 1 of 2

NOTES:

1. Programming RFID Marker Balls:
   A. Prior to burial, utility information is transmitted through a laptop computer to each portable locating device. Locators distinguish between the different types of utility frequencies and between adjacent markers of the same frequency.
2. General Recommendations for Electronic Marker placement (see diagram above).
   B. At valves, one foot north or west of the valve over the main line
   C. At bends, 22.5 degrees and larger
   D. All capped or plugged ends
   E. All casing ends
   F. All tees or crosses over the main line
   G. For single services over the main line at the service tap, if service is not at 90 degrees to the main.
   H. For double services over the main line halfway between the service taps, if service is not 90 degrees to the main.
   I. All water crossings and major road and rail crossings.
   J. All points where the facility crosses over or under other utilities.
   K. Contractors shall certify in writing that electronic markers are in place, prior to paving over any of the above locations. Electronic Markers that are found to be missing shall be installed at the contractor's expense.
   L. Using the GPS interface on the locator will provide positive verification of marker placement during construction and direct data import capability to leading industry standard GIS systems for electronic map updating.
3. Spacing Between Markers
   A. Minimum distance between markers should be at least 6 ft. for clear identification
   B. In straight sections for path marking applications, it is recommended that markers be placed adjacent to existing above ground landmarks such as telephone or power poles. Markers should be placed where there is direct line of sight to the next marker. The maximum distance between markers is 400 ft.
   C. In bends or lateral pipe deflections, it is recommended that one marker be placed for every 1 ft. deflection to accurately indicate pipe position. However, confirm this requirement with the Town's representative.
4. Recommended Marker Spacing and Depth
   A. Maximum distance from ground surface to marker is as follows:
      a. Read Range: 5 ft. read
      b. Maximum installation depth: 5 ft. (detection range).
   B. To increase detection area on surface, contractor may place the marker at half if its rated depth. This will produce a detection area of approximately 6 ft. in diameter.
   C. If fill to finish grade is anticipated, place marker at a 2 ft. depth; this may vary depending on the amount of fill required.
   D. If a cut to finish grade is anticipated, place marker at its maximum rated distance of 5 ft.
   E. If it is anticipated that there will be a need to reprogram the ID marker after it has been buried, place marker at a maximum depth of 1–foot.
5. Standard Tie Down Procedure
   A. Before placing the ball marker over the key point, decide if a tie down procedure is necessary to keep it in place. If so, secure the marker by inserting a cable tie through one or both tie–down tabs and to the key point.
   B. If the key point is metallic, the ball marker must be separated from metallic object with a minimum of 4 in. of clean fill dirt.
   C. Hand fill at least 6 in. of soil over the marker.
   D. Backfill the hole.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

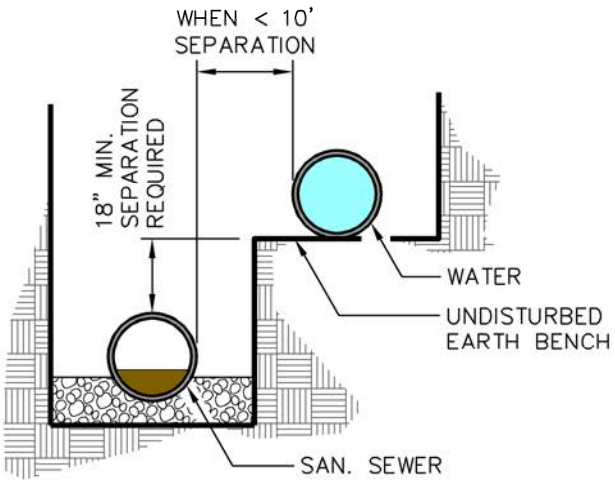
RFID FROM TOWN OF CLAYTON MARKER BALL LOCATIONS DIAGRAM

SCALE:	DETAIL #
Not To Scale	2 C01.04
REVISION DATE: July, 2010	SHEET #: 2 of 2

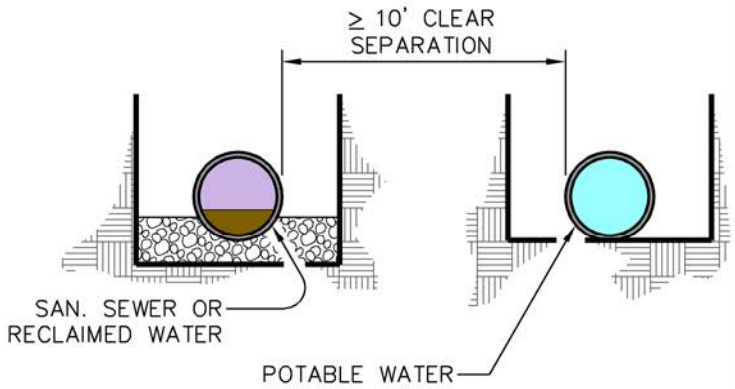
PARALLEL INSTALLATIONS

WATER AND SEWER

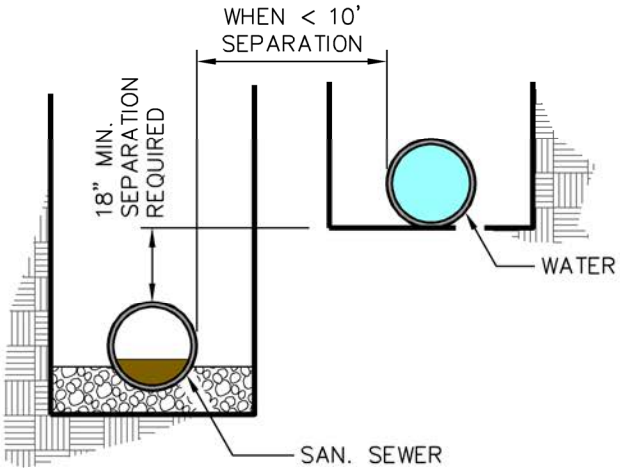
SEPARATION REQUIRED PER SUBCHAPTER 2T OF TITLE 15A OF THE NC ADMINISTRATION CODE.



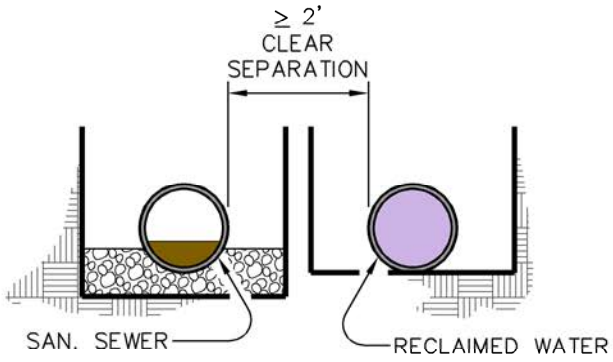
POTABLE WATER
P1 BENCHED CONDITION
< 10' HORIZONTAL SEPARATION



POTABLE WATER
P3 TRENCHED CONDITION
≥ 10' HORIZONTAL SEPARATION



POTABLE WATER
P2 TRENCHED CONDITION
< 10' HORIZONTAL SEPARATION



RECLAIMED WATER
P4 TRENCHED CONDITION
≥ 2' HORIZONTAL SEPARATION

NOTE: IF LESS THAN 2' HORIZONTAL SEPARATION, USE (P1) OR (P2) TYPE INSTALLATION

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

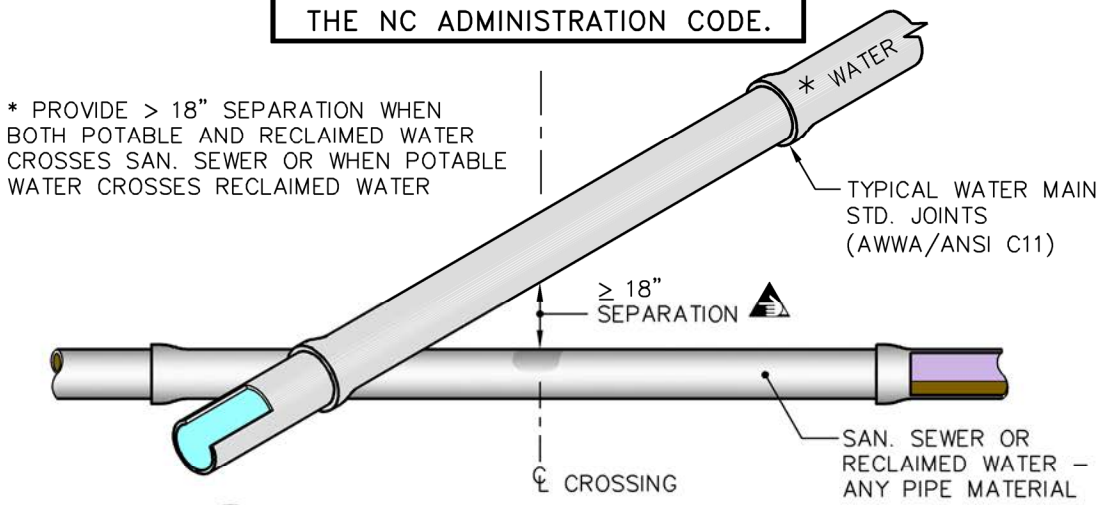
MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE: July, 2010	SHEET #: 1 of 6

PERPENDICULAR CROSSING

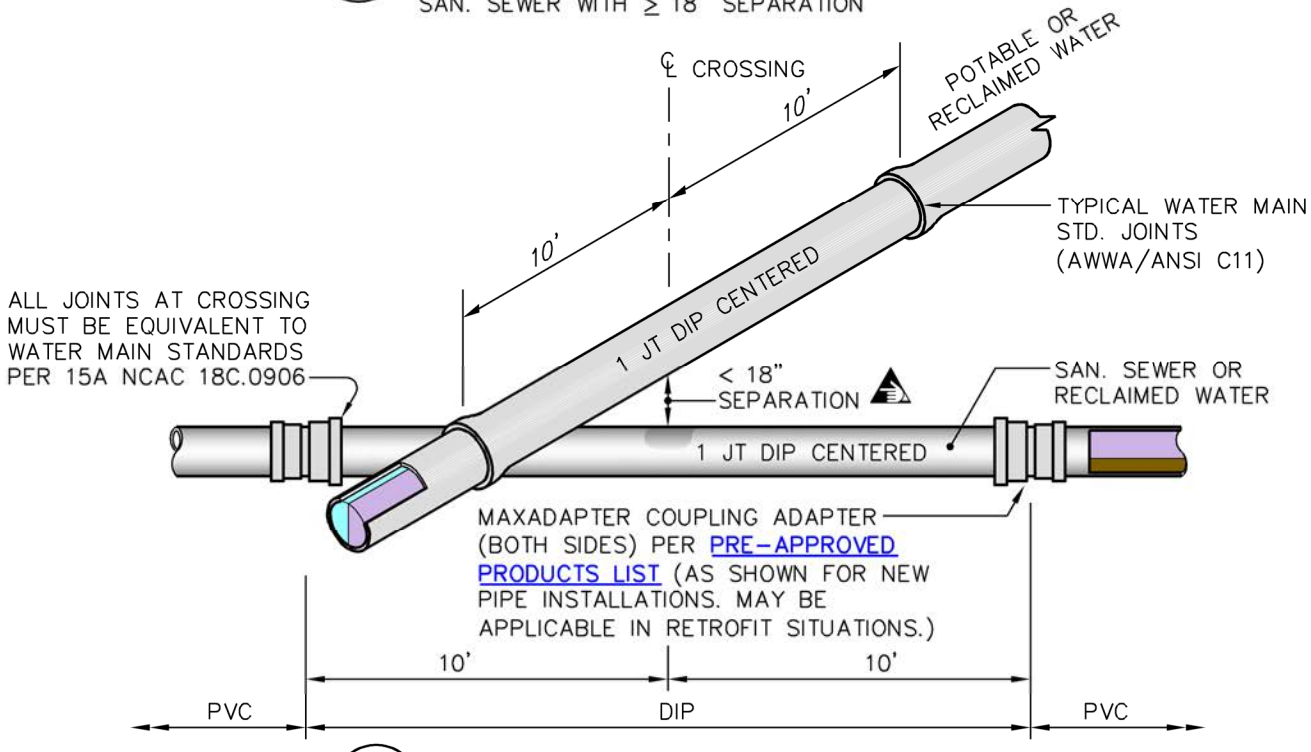
WATER AND SEWER

SEPARATION REQUIRED PER SUBCHAPTER 2T OF TITLE 15A OF THE NC ADMINISTRATION CODE.



C1 PREFERRED CONDITION

POTABLE OR RECLAIMED WATER ABOVE SAN. SEWER WITH ≥ 18" SEPARATION



C2

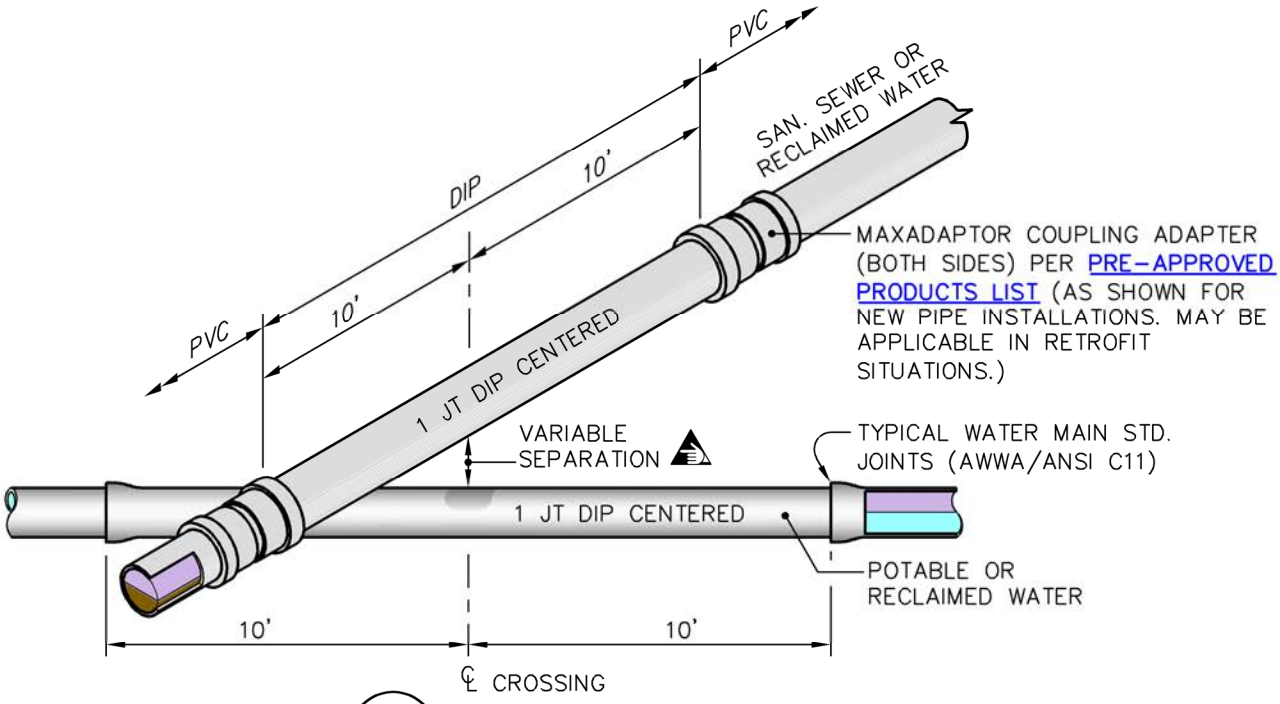
POTABLE OR RECLAIMED WATER ABOVE SAN. SEWER WITH < 18" SEPARATION. (NEW CONSTRUCTION)

TOWN of CLAYTON

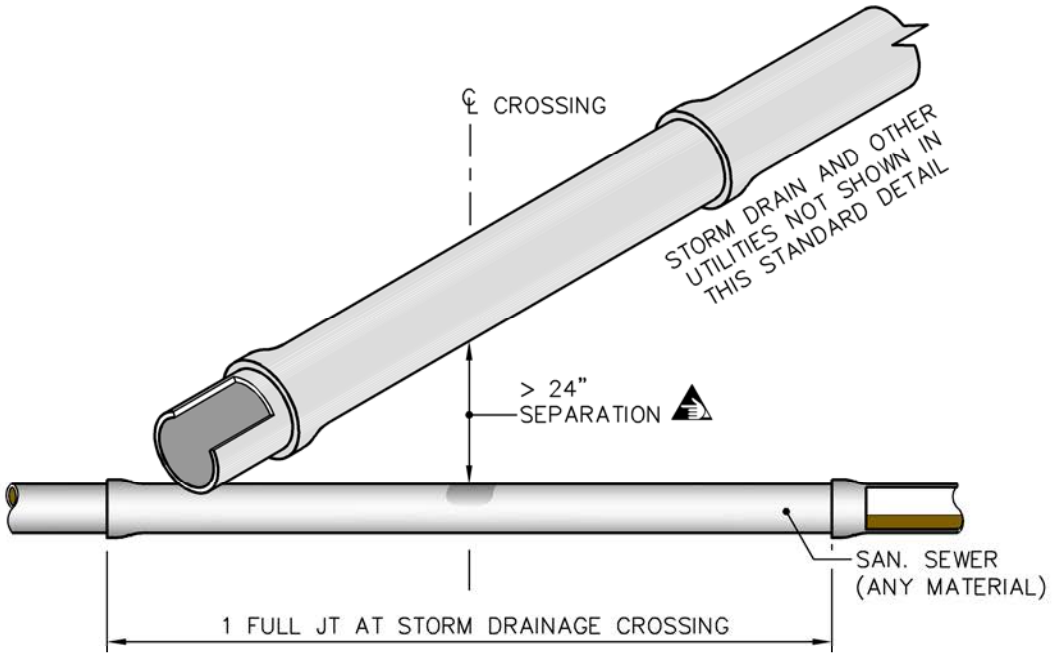
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE: July, 2010	SHEET #: 2 of 6



C3 WATER BELOW SAN. SEWER



C4 PREFERRED CONDITION

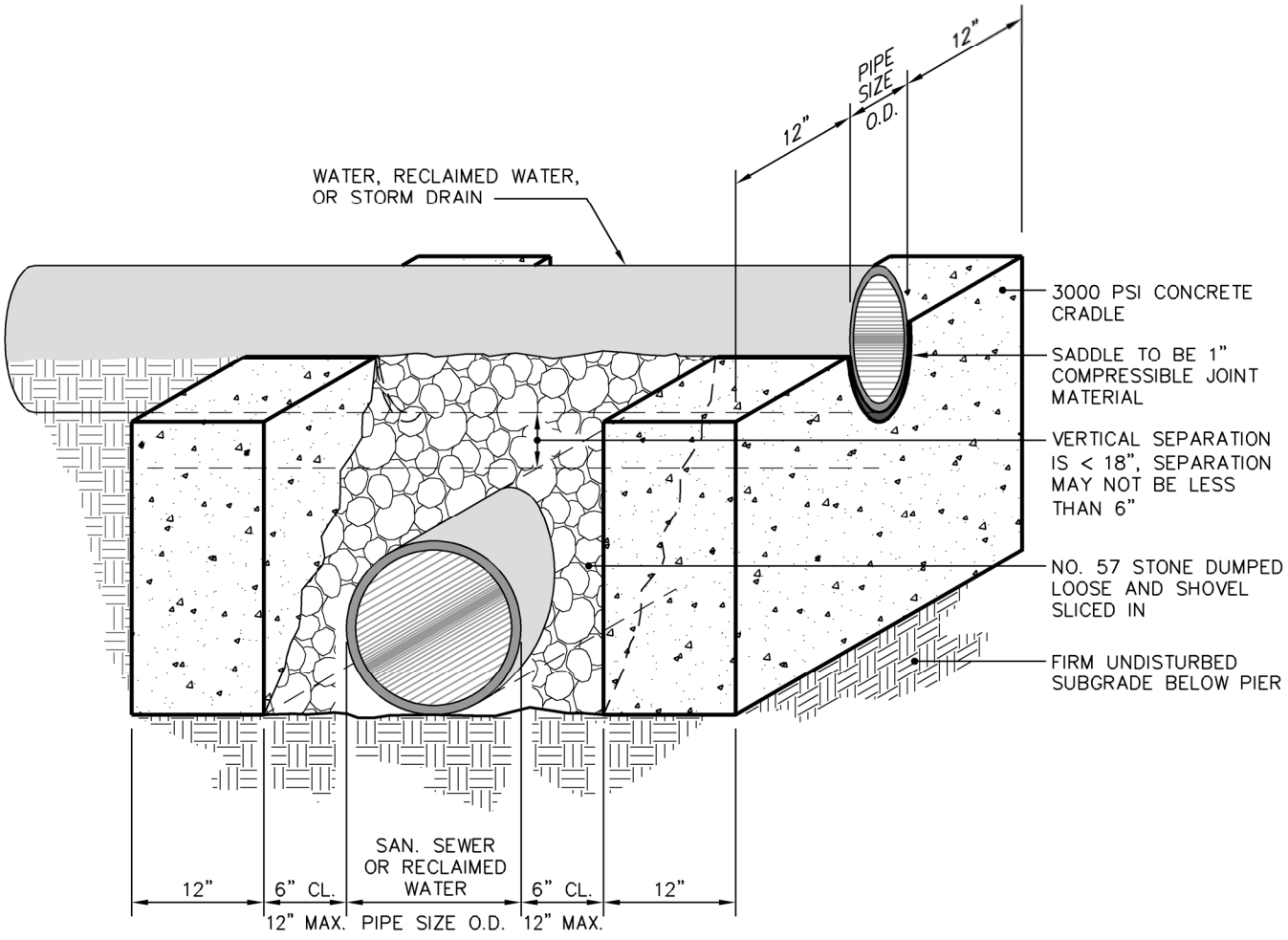
STORM DRAIN ABOVE SAN SEWER WITH ≥ 24" SEPARATION

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE: July, 2010	SHEET #: 3 of 6



C5 VERTICAL SEPARATION

POTABLE WITH ≤ 18" SEPARATION

NOTES

1. Where less than 12" of vertical separation is available between pipes, a concrete saddle between the 2 pipes is required in accordance with this detail. The minimum available separation between pipes with cradle is 6".

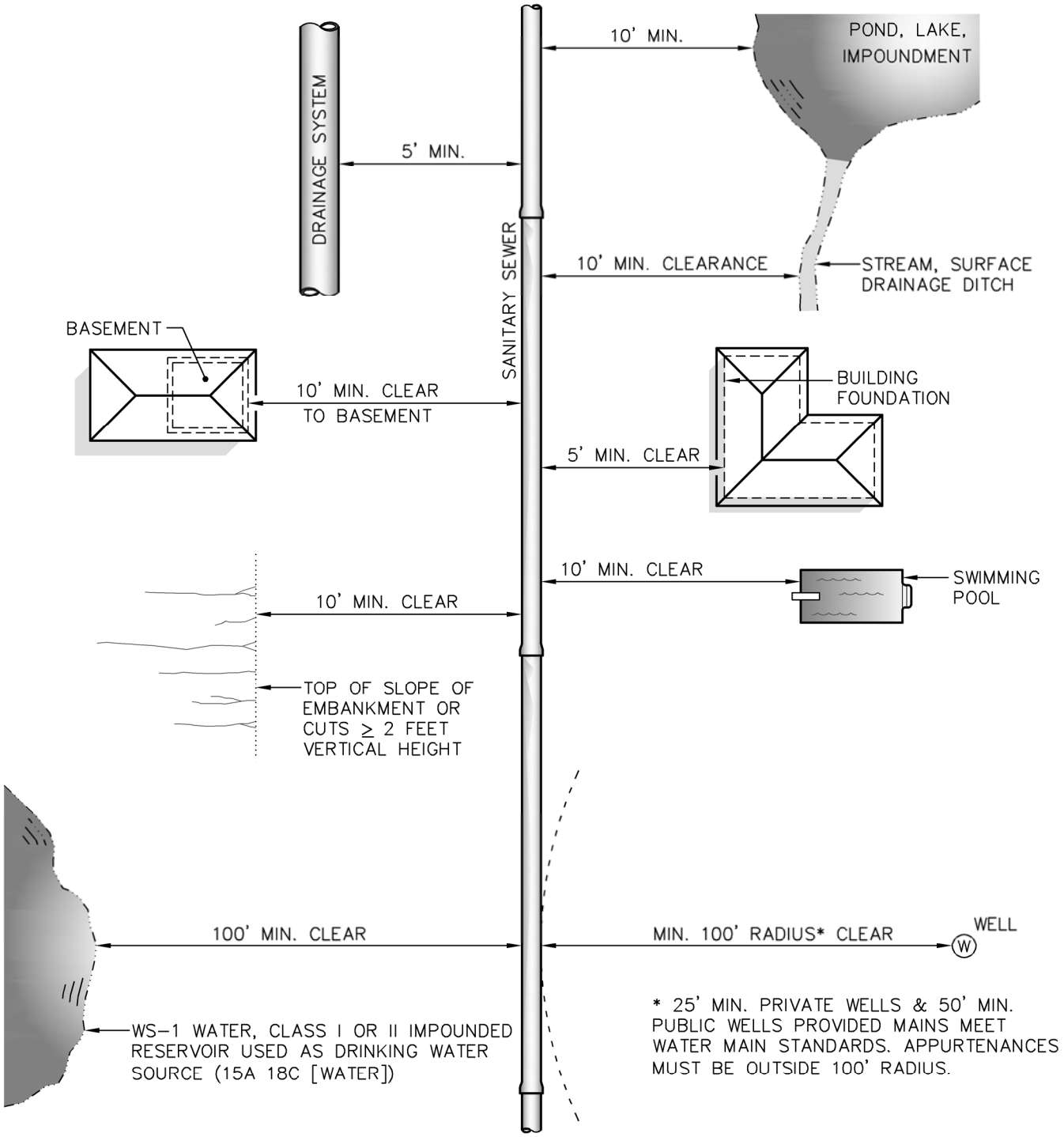
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE:	SHEET #:
July, 2010	4 of 6

MINIMUM LATERAL OFFSET REQUIREMENTS



REFERENCES: 15A NCAC 02L (GROUNDWATER QUALITY STANDARDS), 02C (WELLS), 02T (SEWER), AND 18C (WATER)

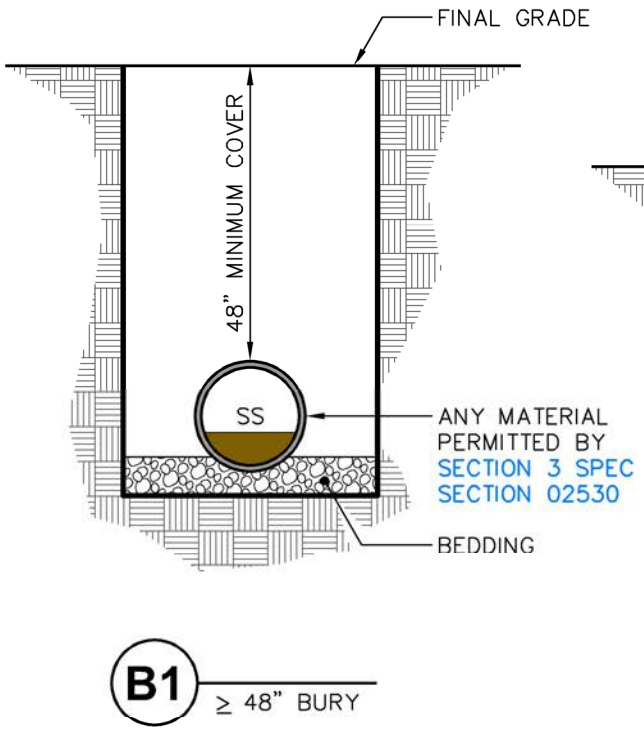
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

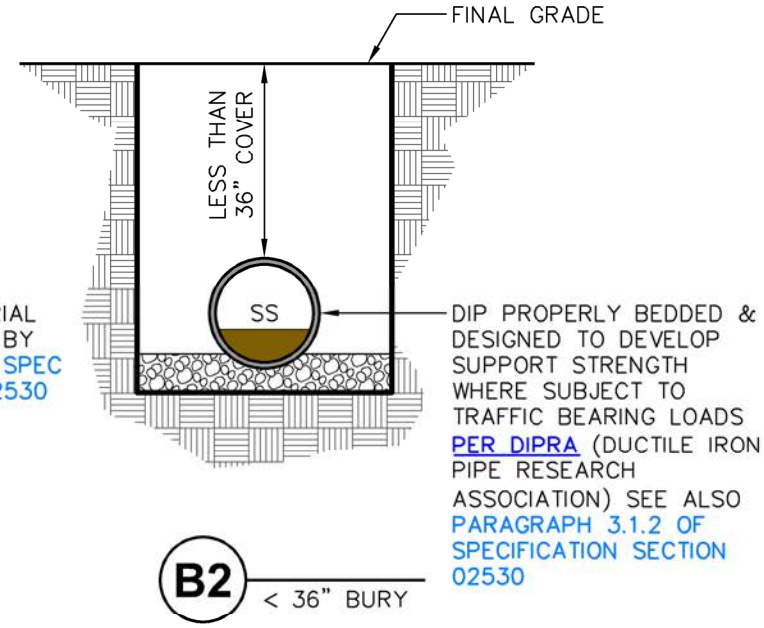
MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE: July, 2010	SHEET #: 5 of 6

SAN. SEWER BURY REQUIREMENTS



B1 ≥ 48" BURY



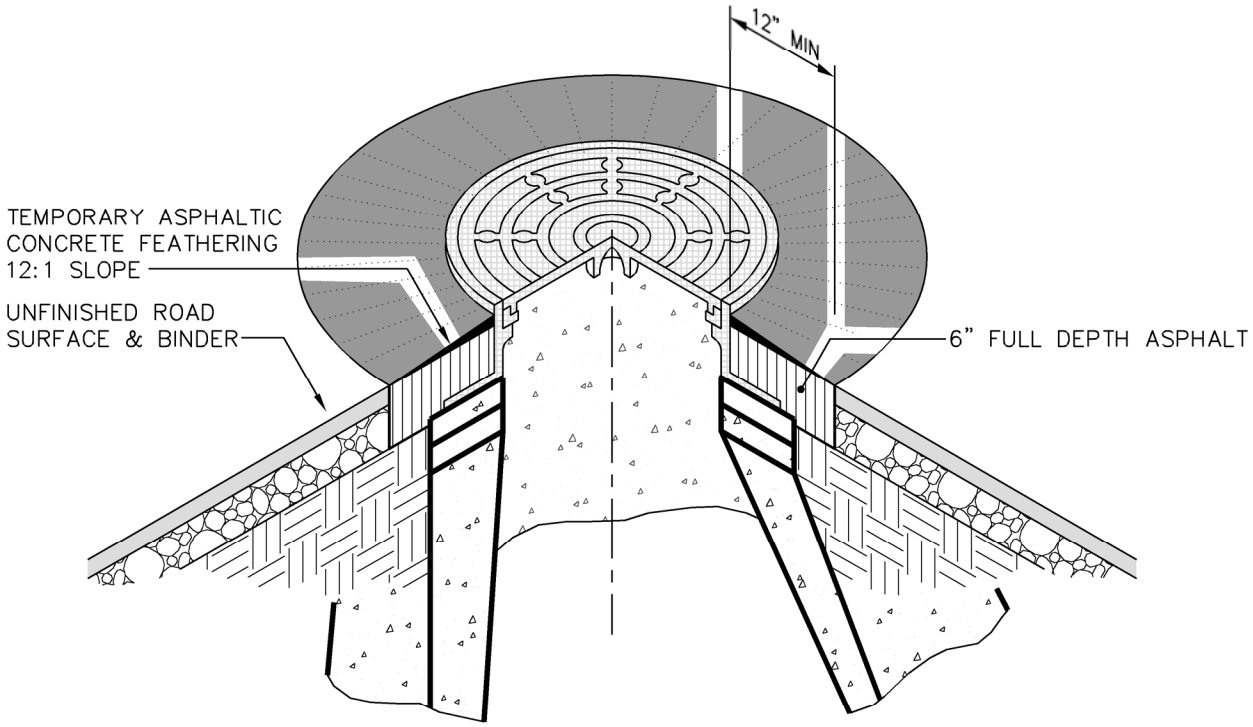
B2 < 36" BURY

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MINIMUM SEPARATION OF UTILITIES AND OTHER FEATURES

SCALE:	DETAIL #
Not To Scale	2 C01.05
REVISION DATE: July, 2010	SHEET #: 6 of 6



NOTES:

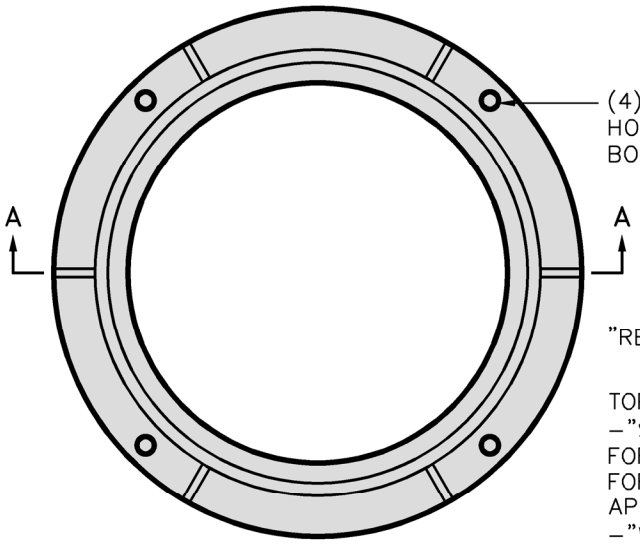
1. When the rim & cover of a manhole or a valve box extends more than 1" above an unfinished road surface, a temporary layer of asphaltic concrete feathering shall be required to provide a smooth transition from 1" below the edge of the rim & cover to the unfinished road surface. A 12 to 1 slope ratio shall be used. The exposed sides of the valve box and/or manhole cover shall be painted bright orange or as specified by town inspector.
2. Prior to final paving contractor shall remove feathering, completely, & apply asphalt tack coat to binder to insure proper asphalt adhesion.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STRUCTURE PROTECTION UNFINISHED ROAD GRADE

SCALE:	DETAIL #
Not To Scale	2 C05.01
REVISION DATE: July, 2010	SHEET #: 1 of 1



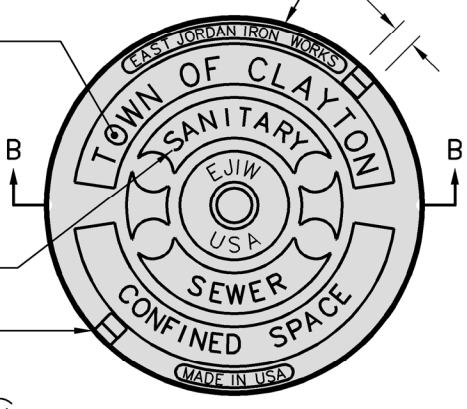
FRAME TOP

THERE ARE TO BE NO VENT HOLES IN A COVER USED FOR GRAVITY SEWER MANHOLE

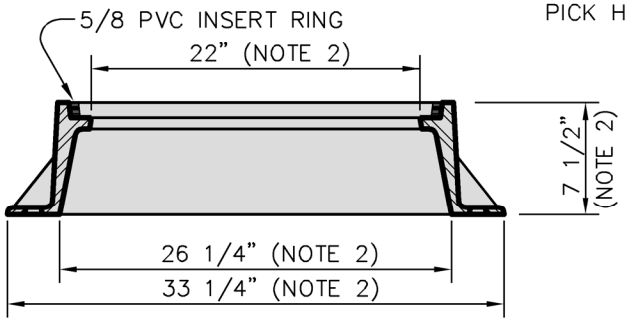
"REQUESTED WORDING"

TOP TO READ:
–"SANITARY SEWER" FOR ALL SEWER AND FORCE MAIN APPLICATIONS.
–"WATER" FOR ALL WATER APPLICATIONS

(2) CLOSED PICK HOLES



COVER FACE

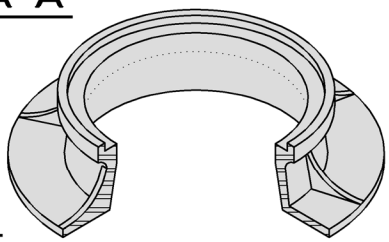


FRAME SECTION A-A

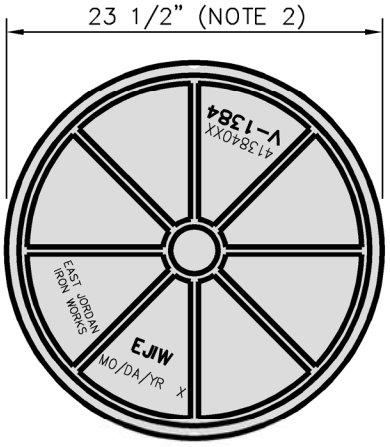


COVER SECTION B-B





ISOMETRICS



COVER BACK

NOTES:

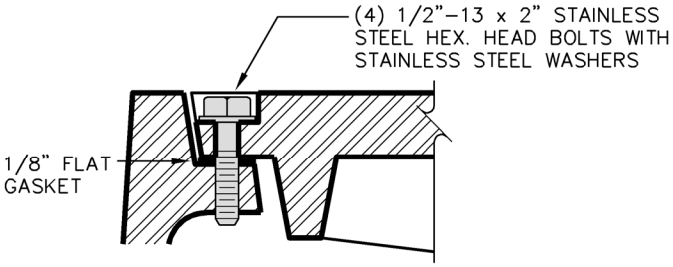
1. Frame & Cover weight may not deviate by more than –5.0%.
2. See Pre-Approved Products List for approved manufacturers and model numbers.

TOWN of CLAYTON

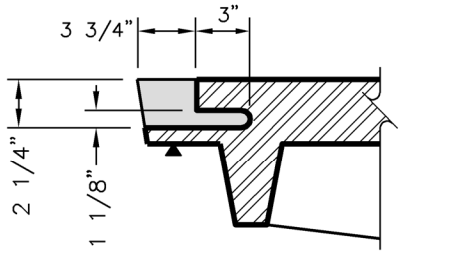
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD MANHOLE FRAME and COVER

SCALE:	DETAIL #
Not To Scale	2 C06.01
REVISION DATE:	SHEET #:
July, 2010	1 of 1

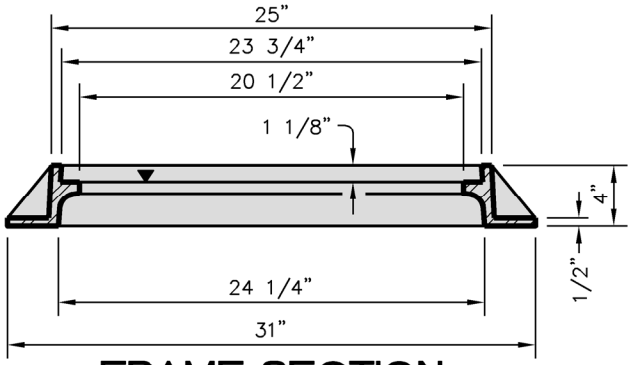


WATERTIGHT DETAIL



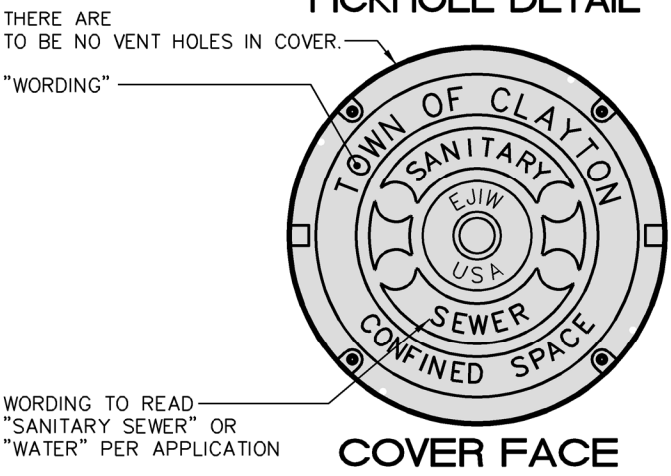
(2) TYPE TWO NON–PENETRATING PICKHOLES

PICKHOLE DETAIL

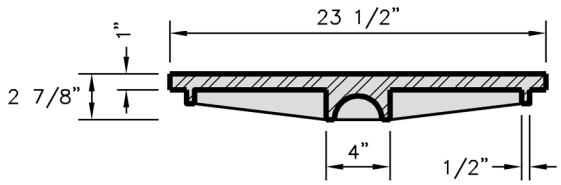


FRAME SECTION

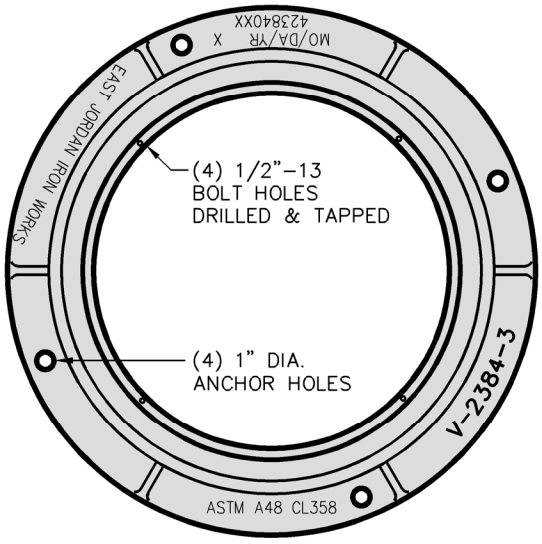
▲ MACHINED SURFACES



COVER FACE

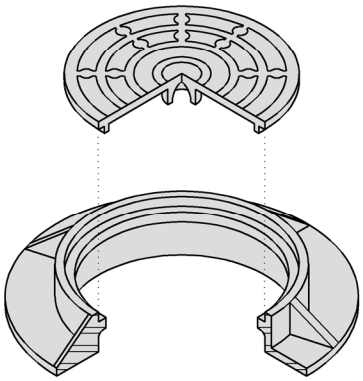


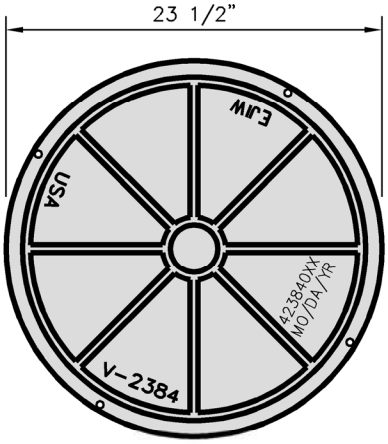
COVER SECTION



FRAME TOP VIEW

ISOMETRIC





COVER BACK

NOTES:

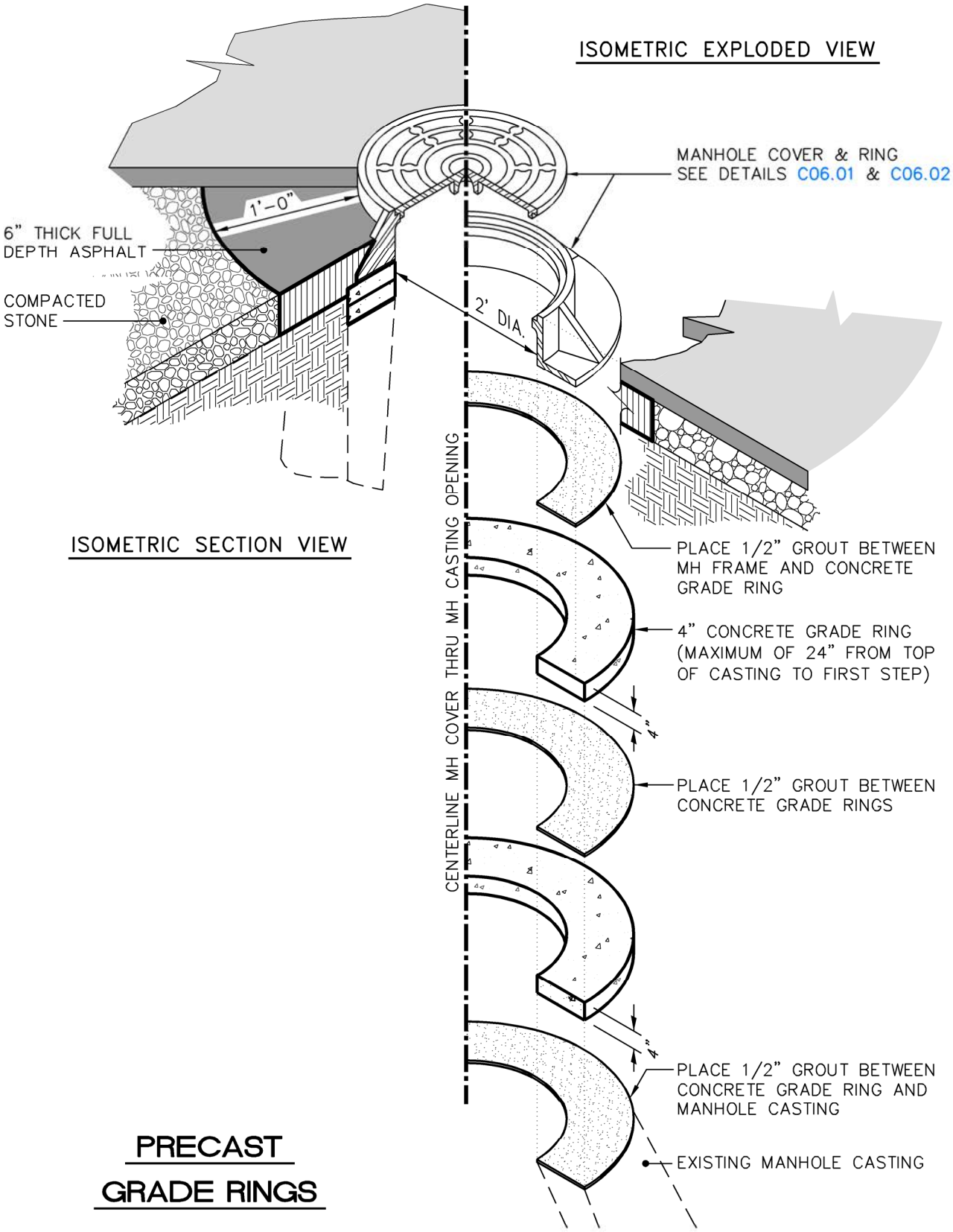
1. Frame & Cover weight may not deviate by more than –5.0%.
2. See Pre–Approved Products List for approved manufacturers and model numbers.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

LOCKABLE MANHOLE FRAME and COVER

SCALE:	DETAIL #
Not To Scale	2 C06.02
REVISION DATE: July, 2010	SHEET #: 1 of 1



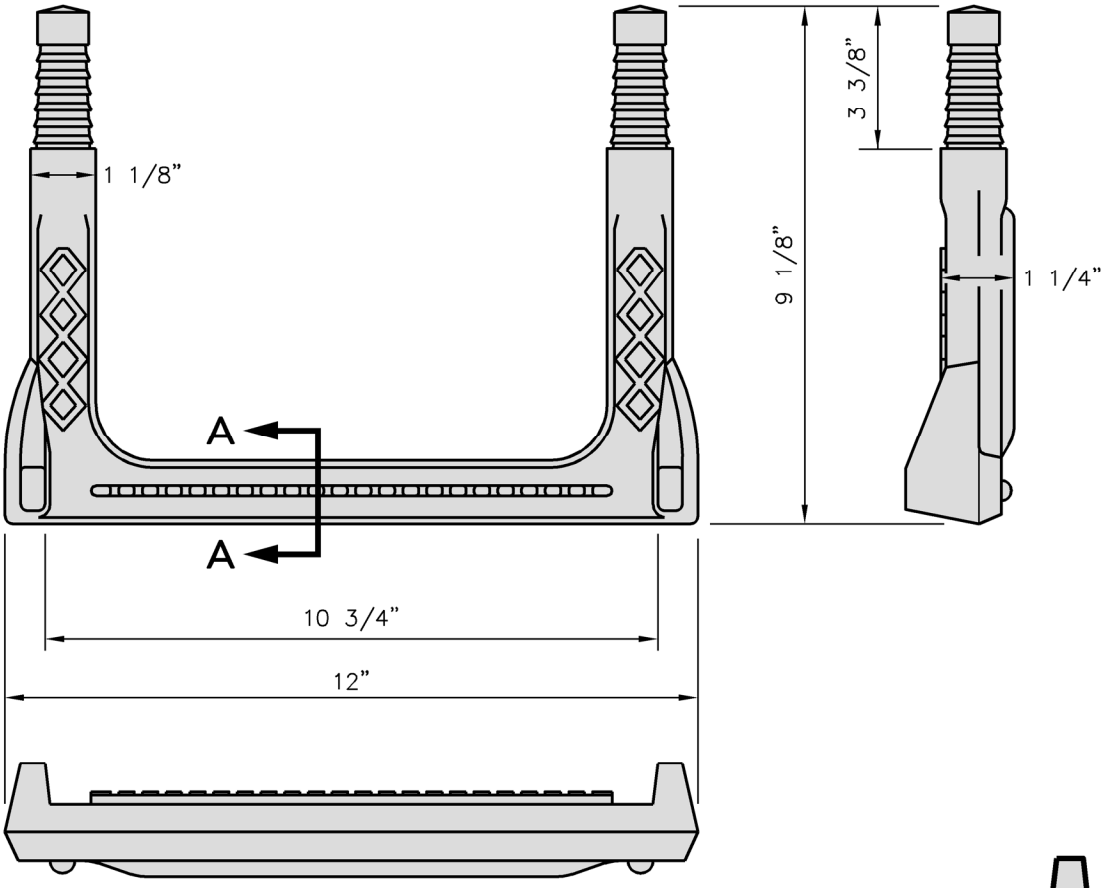
PRECAST GRADE RINGS

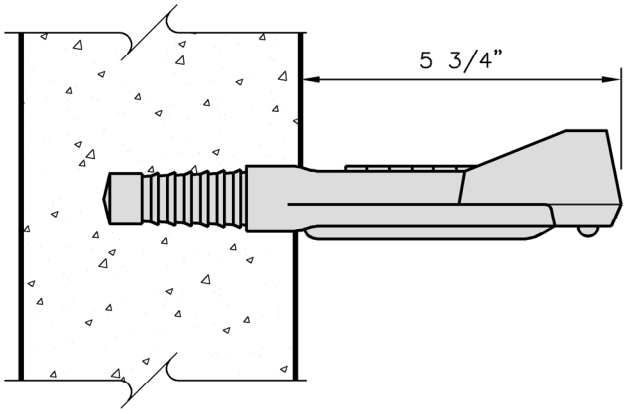
TOWN of CLAYTON

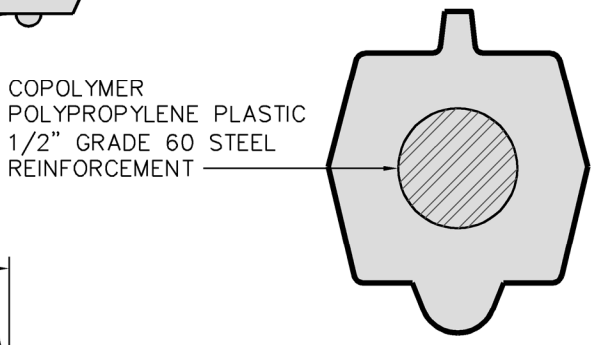
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

MANHOLE RING AND COVER GRADE ADJUSTMENT

SCALE:	DETAIL #
Not To Scale	2 C06.03
REVISION DATE: July, 2010	SHEET #: 1 of 1







SECTION A-A

NOTES:

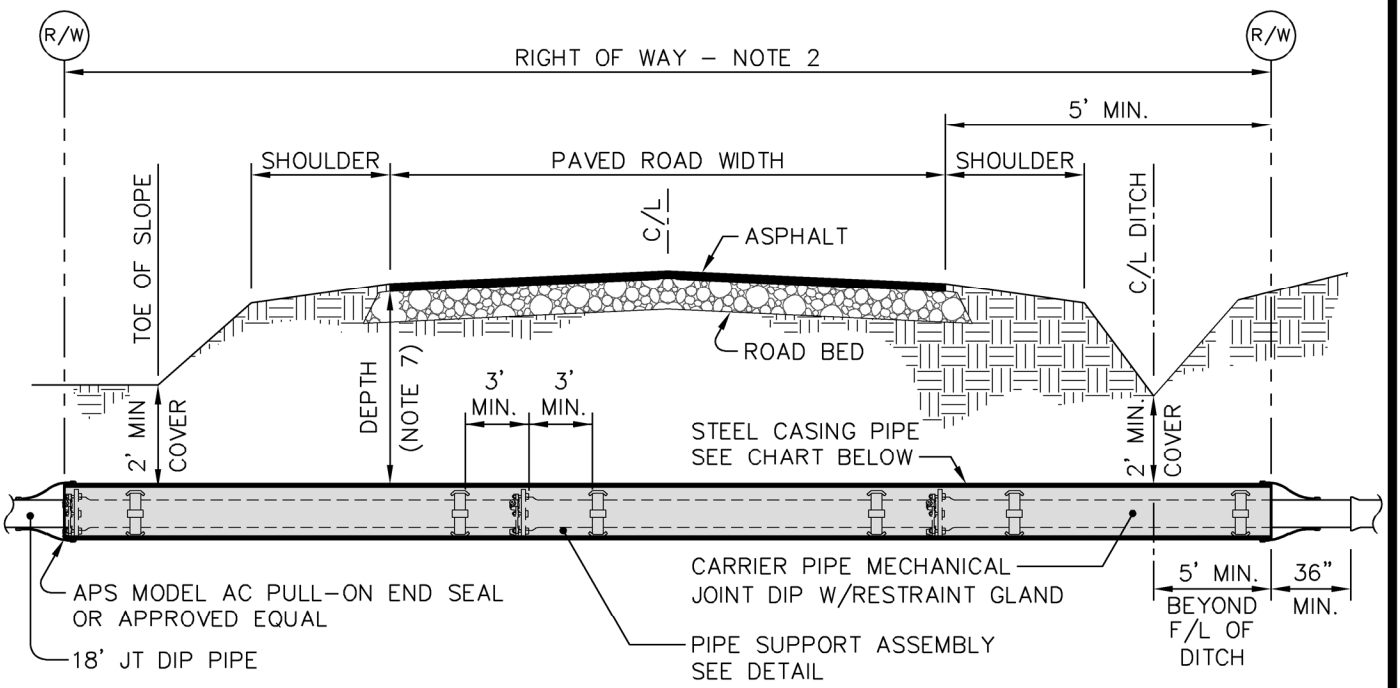
1. See Pre-Approved Products List for approved manufacturers and model numbers.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

POLYPROPYLENE PLASTIC STEP

SCALE:	DETAIL #
Not To Scale	2 C06.04
REVISION DATE: July, 2010	SHEET #: 1 of 1



CARRIER PIPE		CASING PIPE *			
		RAILROAD		HIGHWAY	
NOMINAL DIAMETER	OUTSIDE DIAMETER	OUTSIDE DIAMETER	WALL THICKNESS	OUTSIDE DIAMETER	WALL THICKNESS
6" & UNDER	6.90"	12 3/4"	0.188"	12 3/4"	0.250"
8"	9.05"	16"	0.250"	16"	0.250"
10"	11.10"	20"	0.281"	20"	0.250"
12"	13.20"	24"	0.344"	24"	0.250"
14"	15.30"	28"	0.406"	28"	0.312"
16"	17.40"	30"	0.406"	30"	0.312"
20"	21.60"	42"	0.563"	42"	0.312"
24"	25.80"	42"	0.563"	42"	0.312"

*DIMENSIONS ARE WITHOUT COATINGS

NOTES:

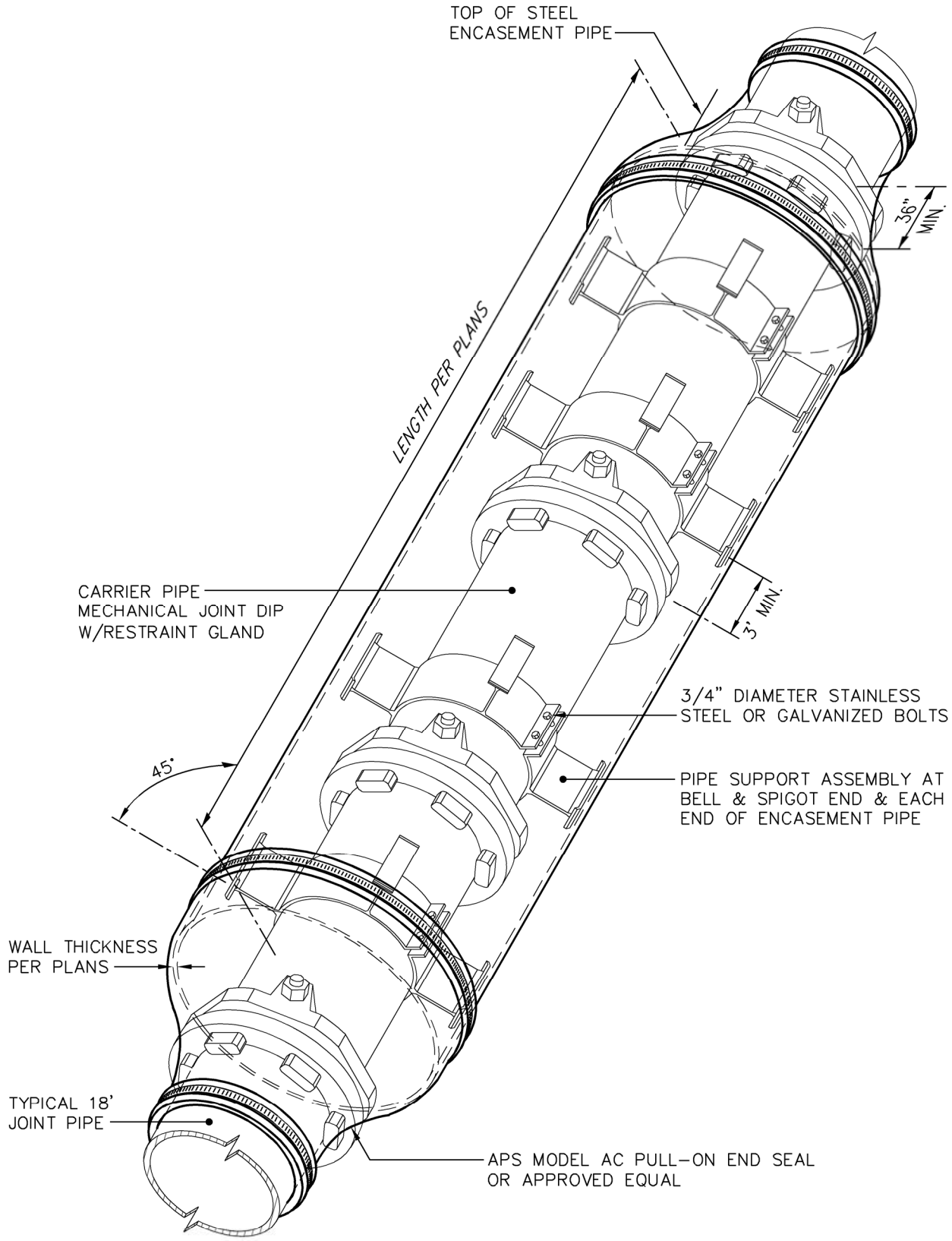
1. Installation by dry bore & jacking.
2. Bore to run from Right-of-Way to Right-of-Way unless approved otherwise by Town of Clayton.
3. Grease encasement pipe as required for ease of installation.
4. Steel pipe to be 35,000 psi min. yield strength, grade B.
5. All exposed metal to be coated with epoxy or asphaltic material.
6. See Pre-Approved Products List for approved skids/spider manufacturer and model numbers.
7. Depth as necessary to meet minimum cover and/or minimum utility seperation requirements.
8. Provide vents for encasement only when directed by Engineering Director. Include a turn down elbow and stainless steel insect screen.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL DETAIL for BORE UNDER PAVED ROADS / HIGHWAYS

SCALE:	DETAIL #
Not To Scale	2 C07.01
REVISION DATE: July, 2010	SHEET #: 1 of 2

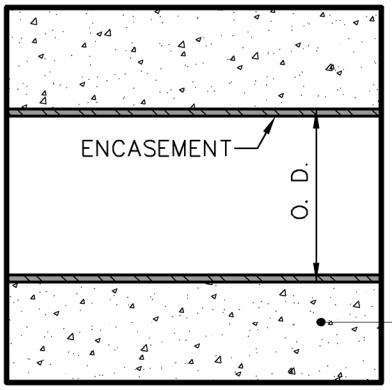


TOWN of CLAYTON

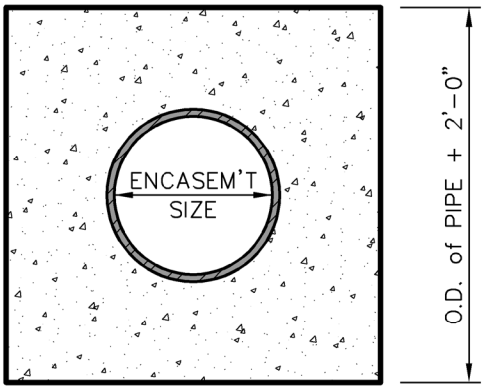
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL DETAIL for BORE UNDER PAVED ROADS / HIGHWAYS

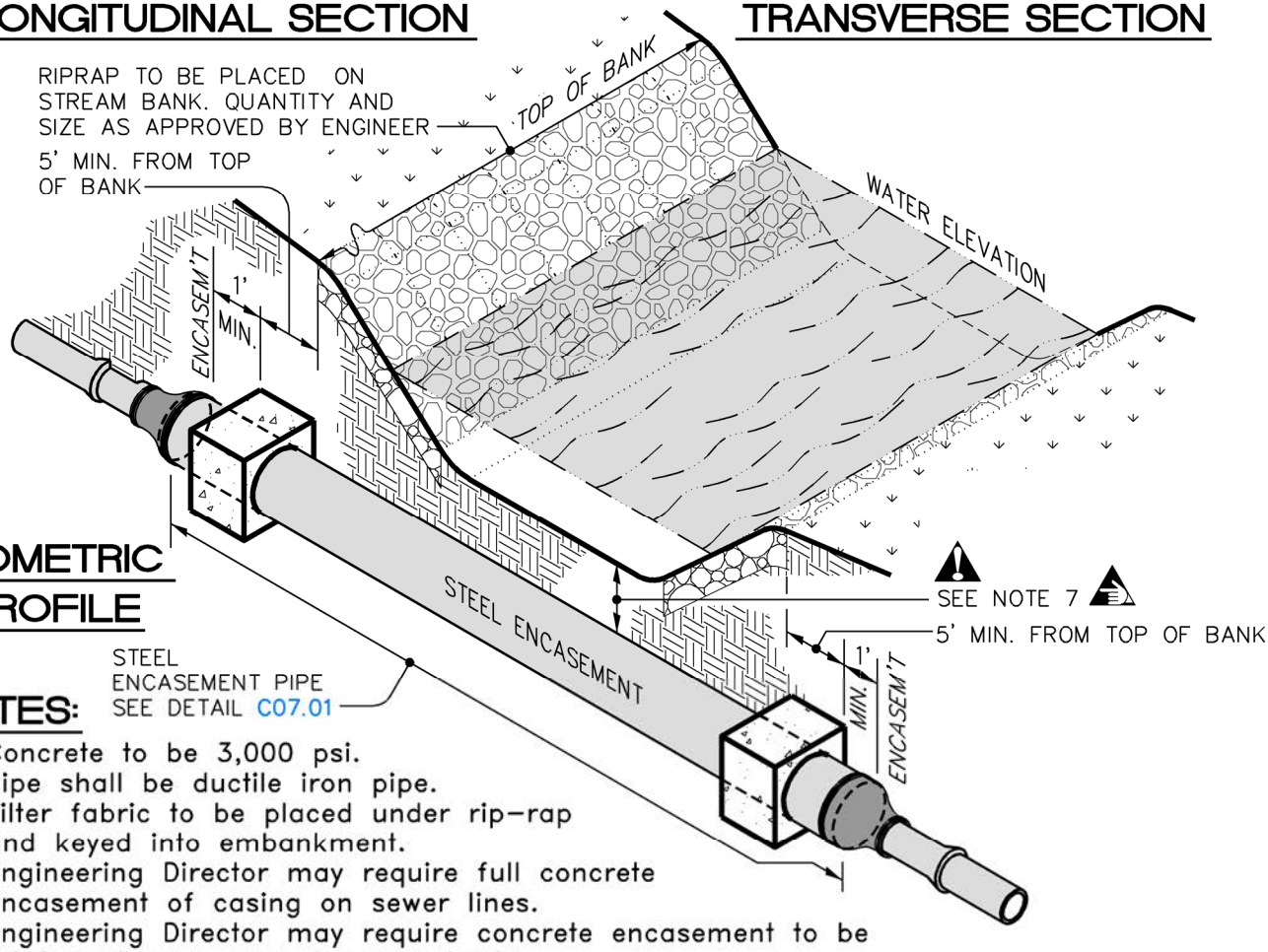
SCALE:	DETAIL #
Not To Scale	2 C07.01
REVISION DATE: July, 2010	SHEET #: 2 of 2



LONGITUDINAL SECTION



TRANSVERSE SECTION



ISOMETRIC PROFILE

NOTES:

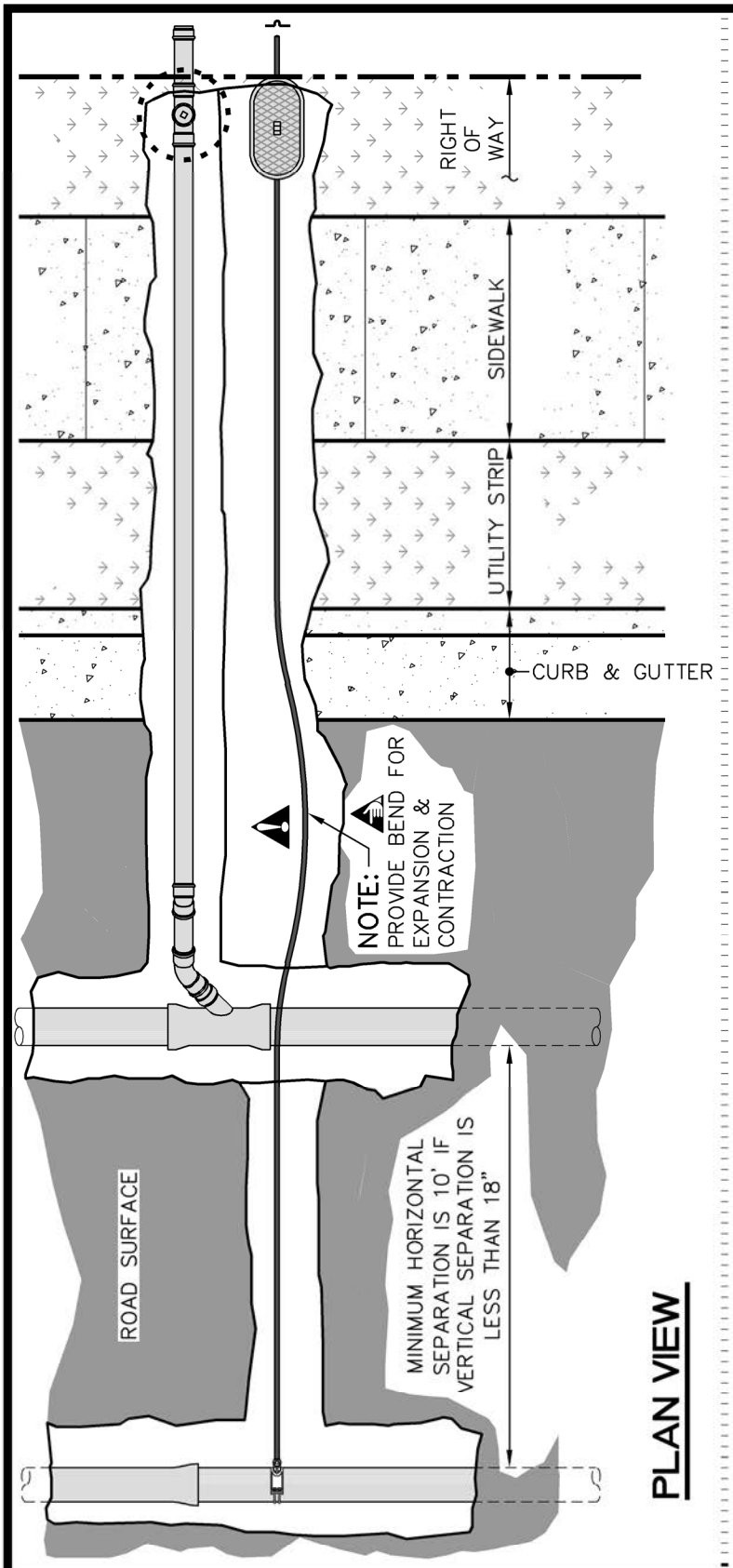
1. Concrete to be 3,000 psi.
2. Pipe shall be ductile iron pipe.
3. Filter fabric to be placed under rip–rap and keyed into embankment.
4. Engineering Director may require full concrete encasement of casing on sewer lines.
5. Engineering Director may require concrete encasement to be reinforced on a case–by–case basis.
6. All stream xings shall require steel casing. See detail C07.01. Valves shall be a minimum of 20 ft from end of casing if valves are in line with casing.
7. Clearance from stream bed to top of encasement shall be a minimum of 2'–0". If this line is a waterline, provide a minimum of 30" of cover & 5'–0" of cover if water course is wider than 15'.
8. Provide vents for encasement only when directed by Engineering Director. Include a turn down elbow and stainless steel insect screen.

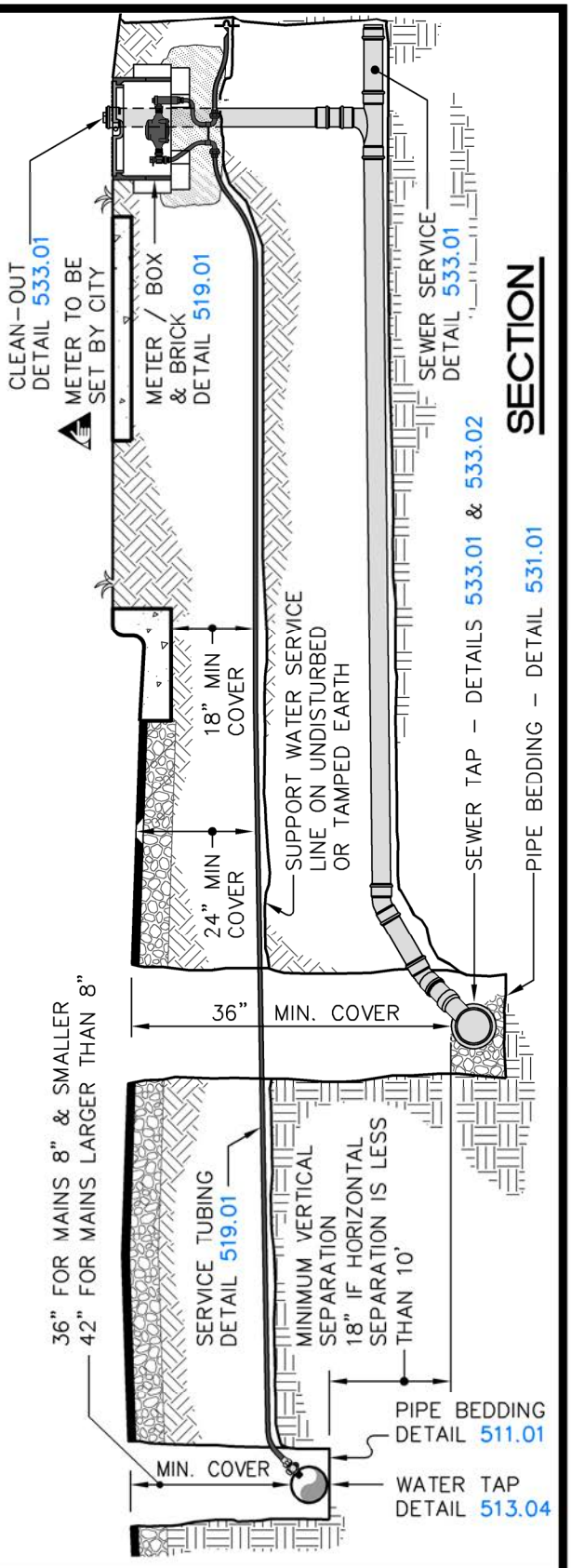
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD STREAM/CREEK CROSSING

SCALE:	DETAIL #
Not To Scale	2 C07.02
REVISION DATE: July, 2010	SHEET #: 1 of 1





TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL RESIDENTIAL WATER & SEWER SERVICE SCHEMATIC

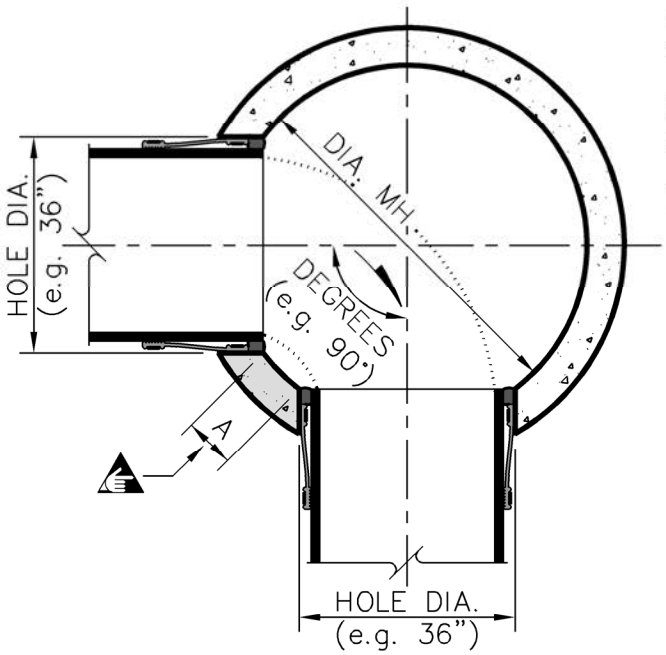
SCALE:	DETAIL #
Not To Scale	2 C07.03
REVISION DATE: July, 2010	SHEET #: 1 of 1

To calculate the closest possible distance between two holes (openings) on the same horizontal centerline, use the following formula:

A = Distance between holes (in degrees)
B = Angle between centerline of pipes
C = Degrees for hole number one from chart below
D = Degrees for hole number two from chart below

$A = B - 1/2(C+D)$

If A < 0, the openings are overlapping
If A > 0, A = the distance between holes (in degrees)



4' DIA:
A = 90 – 1/2(95+95) = 90 – 95 = –5, *Holes too close*

5' DIA:
A = 90 – 1/2(75+75) = 90 – 75 = 15, *O.K. for 5' dia.*

There are 15° of angle between holes which is 7 7/8".

4' Dia. MH	
Hole Dia.	Degrees
12"	28°
12"	28°
18"	45°
24"	60°
30"	76°
36"	95°

5' Dia. MH	
Hole Dia.	Degrees
12"	22°
18"	35°
24"	48°
30"	62.6°
36"	75°
40"	82°
48"	108°

6' Dia. MH	
Hole Dia.	Degrees
12"	20°
16"	25°
20"	32°
24"	38°
36"	60°
40"	65°
43"	70°
48"	84°
55"	98°
63"	125°

8' Dia. MH	
Hole Dia.	Degrees
12"	15°
18"	22°
24"	28°
36"	44°
40"	48°
42"	52°
48"	60°
55"	68°
60"	80°
70"	90°
78"	108°

10' Dia. MH	
Hole Dia.	Degrees
12"	12°
18"	18°
24"	24°
36"	36°
40"	38°
48"	46°
55"	55°
62"	62°
70"	70°
78"	80°

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

DISTANCE BETWEEN TWO HOLES (OPENINGS) FORMULA

SCALE: Not To Scale
DETAIL # 2 C09.01
REVISION DATE: July, 2010
SHEET #: 1 of 1

Fall Permanent Seeding — August 15 – November 1

Lime	2 tons/ac
5–10–10 Fertilizer	1000 lbs/ac
0–20–0	500 lbs/ac
Unscarified Service Lespedeza	60 lbs/ac
Ky–31 Fescue	30 lbs/ac
Rye Grain	25 lbs/ac
★Straw Mulch	2 tons/ac

Fall Permanent Seeding – Centipede: — September 1 – February 28

Lime	2 tons/ac
Fertilizer (low nitrogen approved for Centipede)	(Appropriate fertilizer approved for centipede application)
Rye Grain	90 lbs/ac
Centipede Seed	15 lbs/ac (overseeded in spring)
★Straw Mulch	2 tons/ac

Winter Temporary Cover — November 1 – February 28

Lime	2 tons/ac
10–10–10 Fertilizer	700 lbs/ac
Oats	50 lbs/ac
Rye Grain	20 lbs/ac
★Straw Mulch	2 tons/ac

Spring Permanent Seeding — March 1 – April 30

Lime	2 tons/ac
5–10–10 Fertilizer	1000 lbs/ac
0–20–0	500 lbs/ac
Scarified Sericea Lespedeza	50 lbs/ac
Ky–31 Fescue	30 lbs/ac
Browntop Millet	20 lbs/ac
★Straw Mulch	2 tons/ac

Spring Permanent Seeding – Centipede: — April 1 – July 15

Lime	2 tons/ac
Fertilizer (low nitrogen approved for Centipede)	(Appropriate fertilizer approved for centipede application)
Centipede Seed	90 lbs/ac
★Straw Mulch	2 tons/ac

Late Spring Permanent Seeding — March 15 – June 30

Lime	2 tons/ac
10–10–10 Fertilizer	1000 lbs/ac
0–20–0	500 lbs/ac
Scarified Sericea Lespedeza	40 lbs/ac
Common Bermuda Grass (hulled)	8 lbs/ac
★Straw Mulch	2 tons/ac

Summer Temporary Cover — June 30 – August 3

Lime	2 tons/ac
10–10–10 Fertilizer	700 lbs/ac
Browntop Millet	40 lbs/ac
★Straw Mulch	2 tons/ac

NOTES:

1. ★ Mulch will be doubled if crimping is the method used.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

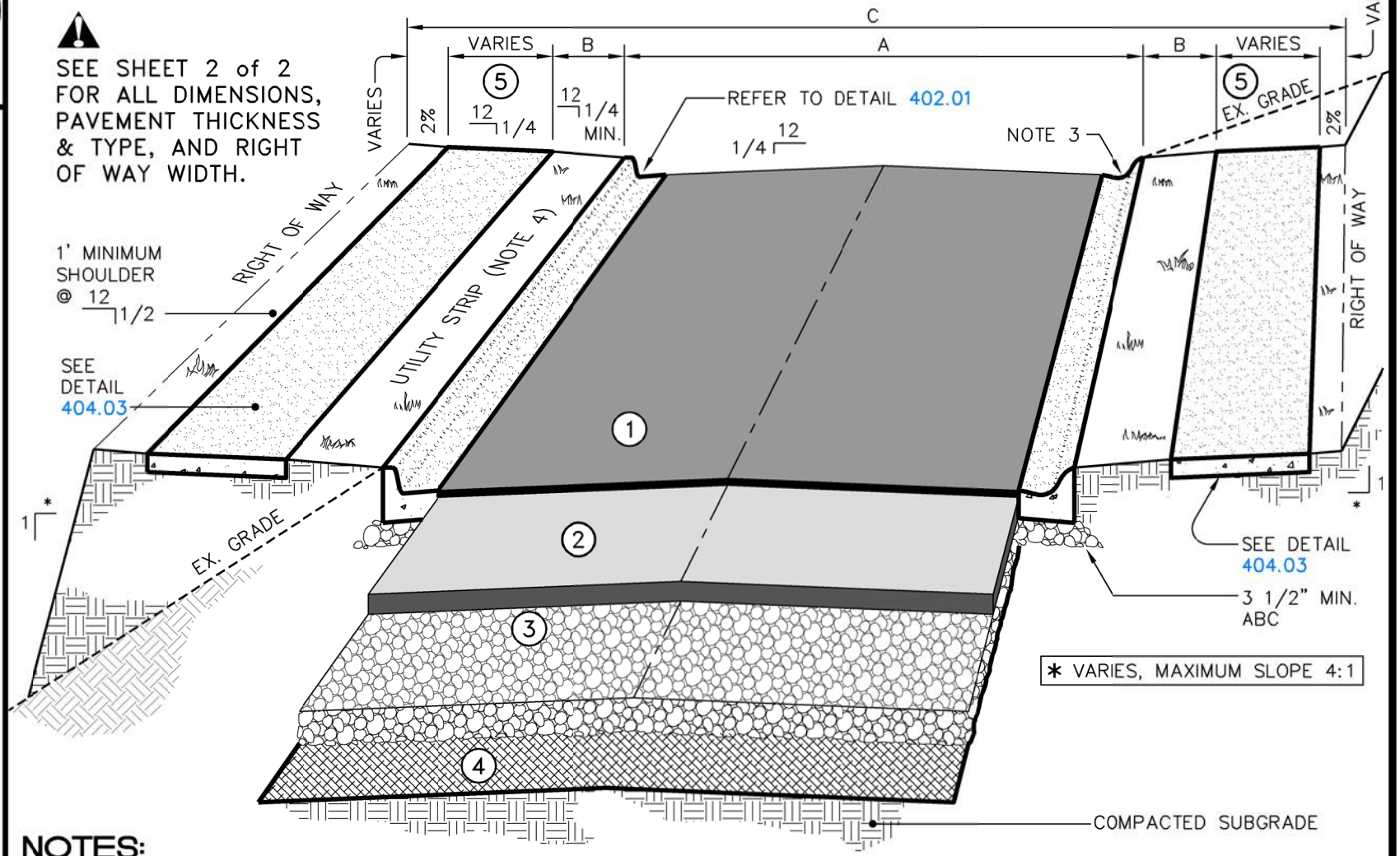
SEEDING SPECIFICATIONS

SCALE: Not To Scale	DETAIL # 2 350.01
REVISION DATE: July, 2023	SHEET #: 1 of 1

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY



NOTES:

1. Pavement design, pavement width, and street right of way shall be as shown unless otherwise specified. Where unusual conditions exist, or excessive traffic volume is anticipated, the project engineer may vary the typical street section or pavement design accordingly.
2. Refer to plan cross-sections for slope tie-ins.
3. Mountable roll curb and gutter may be used in lieu of straight back curb on residential and residential collectors.
4. Utility Strip must allow sidewalk to drain.

SCALE:	DETAIL #
Not To Scale	401.01
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Details Provided by APPIAN Consulting Engineers – www.appianengineers.com
11/06/2024 – 11:18:02 AM

Roadway Geometric Properties Matrix

Facility Classification	C&G Application Back to Back (Ft) (minimum)	Minimum Utility Strip Back to Back (Ft) if applicable [c]	Minimum ROW (ft)	Pavement Section				Sidewalk Required (one side, both or none)
				Riding Surface (minimum)	Asphalt Base (minimum)	Aggregate Base (minimum)	Geogrid Required Between Earth Subgrade and Stone Base	
	A	B	C	1	2	3	4	5
Residential cul-de-sacs	29'	6'	55'	3" S 9.5B	-	8"	-	-
Commercial cul-de-sacs	31'	3'	60'	3" S 9.5B	-	8"	-	-
Residential Streets	29'	6'	55'	3" S 9.5B	-	8"	-	Both
Residential Collector	30'	8'	70'	3" S 9.5B	-	8"	-	Both
Frontage Road	29'	8'	50'	3" S 9.5B	-	8"	-	One
Collector	40'	8'	80'	2" S 9.5B	2 ½" B 25.X	8"	-	Both
Minor Thoroughfare – 2 Lane w/ parking on one side	35'	8'	75'	2" S 9.5B	2 ½" B 25.X	8"	Yes	Both
Minor Thoroughfare [a] – 3 Lane	41'	7.5'	80'	2" S 9.5B	4" B 25.X	8"	Yes	Both [b]
Major Thoroughfare [a] – 2 Lane divided	66'	5'	100'	3" S 9.5C	6" B 25.X	8"	Yes	Both [b]
Major Thoroughfare [a] – 4 Lane divided	74'	6'	110'	3" S 9.5C	6" B 25.X	10"	Yes	Both [b]
Major Thoroughfare [a] – 6 Lane divided	98'	6'	134'	3" S 9.5C	6" B 25.X	10"	Yes	Both [b]
Alley	20' strip paved	Varies per detail 401.01 sheet 6	30' Easement	3" S 9.5B	-	8"	-	-

a. Minimum non-residential paved lane width = 12' ft.
b. For shared Pedestrian & Bicycle Facility, use 10' minimum width on one of sidewalks.
c. Street trees to be added to all street sections with a 4' or greater utility strip.

NOTES:

1. The compacted subgrade and the aggregate base must pass proof roll before constructing next stage.
2. All minimum paving sections to be verified or increased as required by Geotechnical Engineer based on site investigation.

NORTH CAROLINA 1869 CLAYTON

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

SCALE: Not To Scale

REVISION DATE: July, 2023

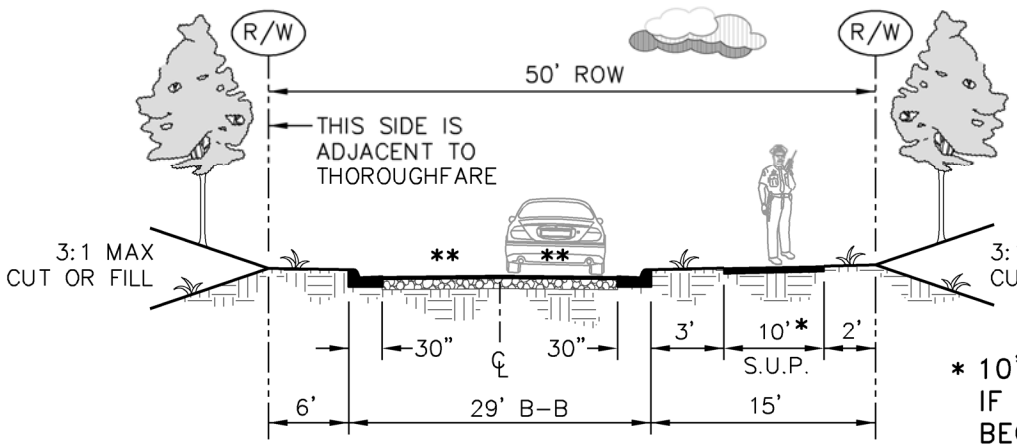
DETAIL # 401.01

SHEET #: 2 of 6

Details Provided by APPIAN Consulting Engineers – www.appianengineers.com

11/06/2024 – 11:17:53 AM

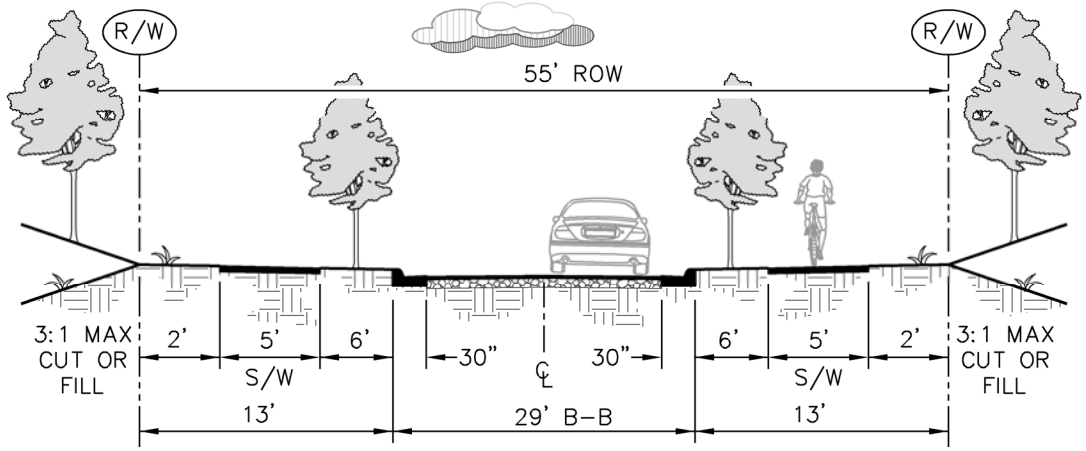
S.U.P. = SHARED USE PATH



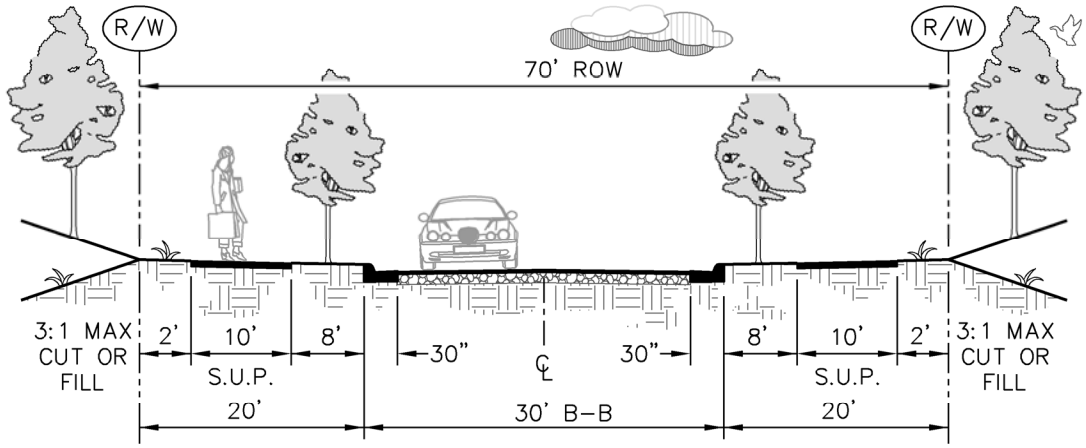
FRONTAGE ROAD

* 10' SHARED USE PATH IF FRONTAGE ROAD BECOMES BACKAGE RD.

** MIN. 12' TRAVEL LANE



RESIDENTIAL STREET



RESIDENTIAL COLLECTOR STREET

NOTES:

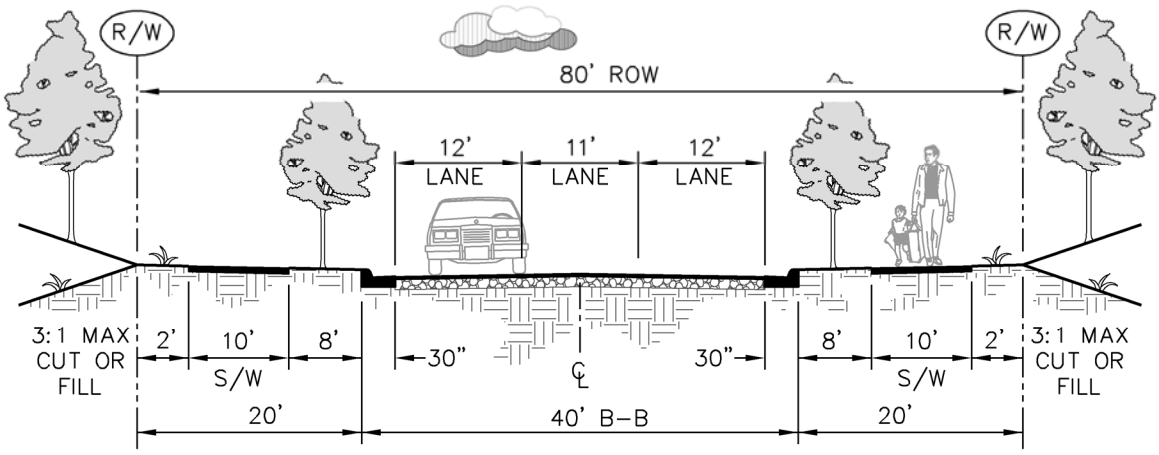
1. See sheet 1 & 2 for pavement properties & matrix.

TOWN of CLAYTON

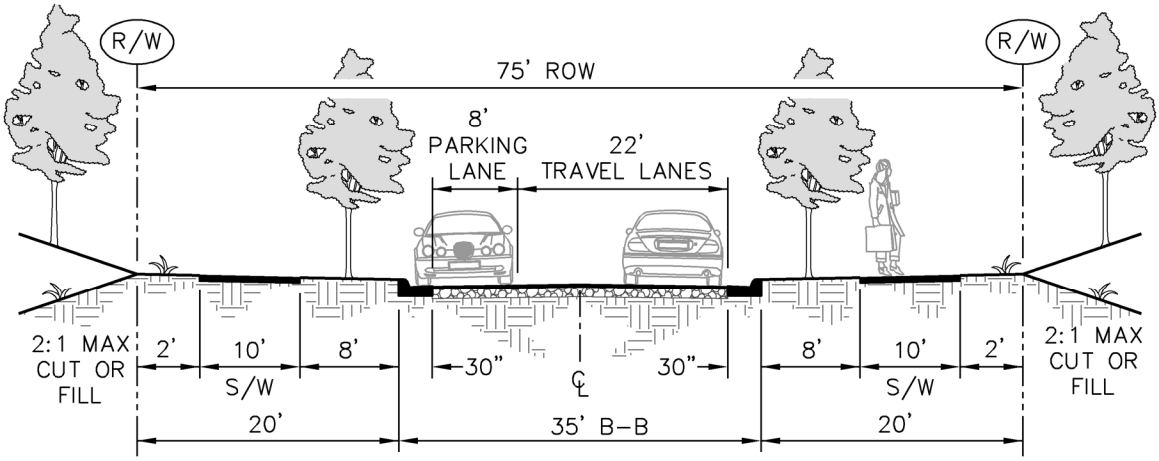
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

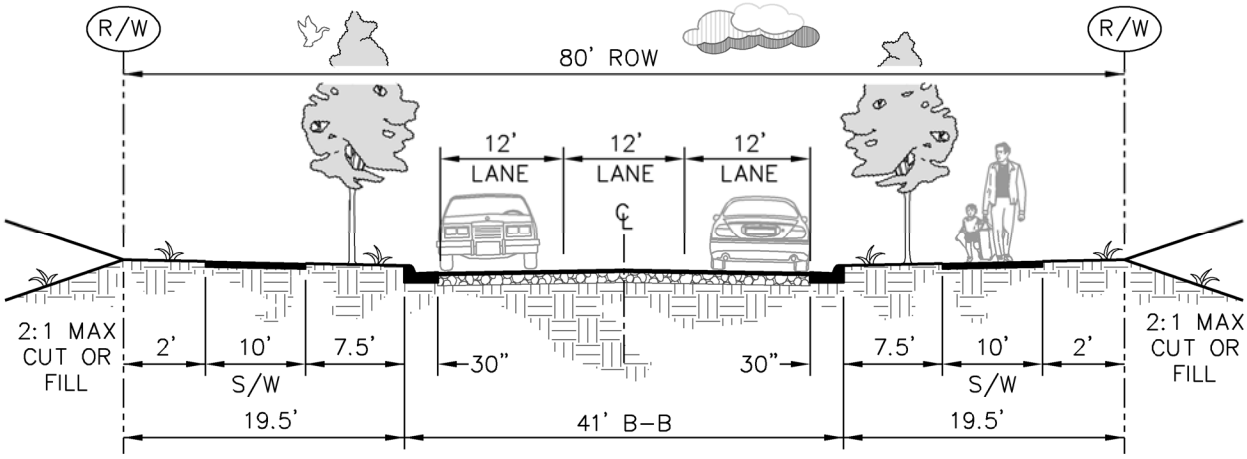
SCALE:	DETAIL #
Not To Scale	2401.01
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COLLECTOR STREET



MINOR THOROUGHFARE - TWO LANE



MINOR THOROUGHFARE - THREE LANE

NOTES:

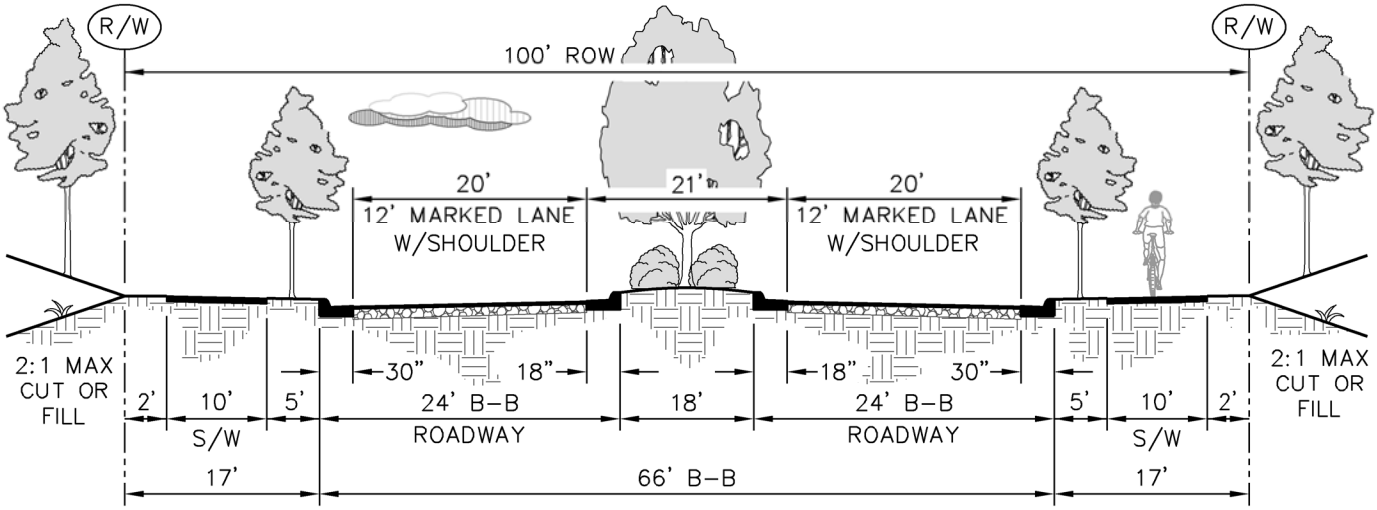
1. See sheet 1 & 2 for pavement properties & matrix.

TOWN of CLAYTON

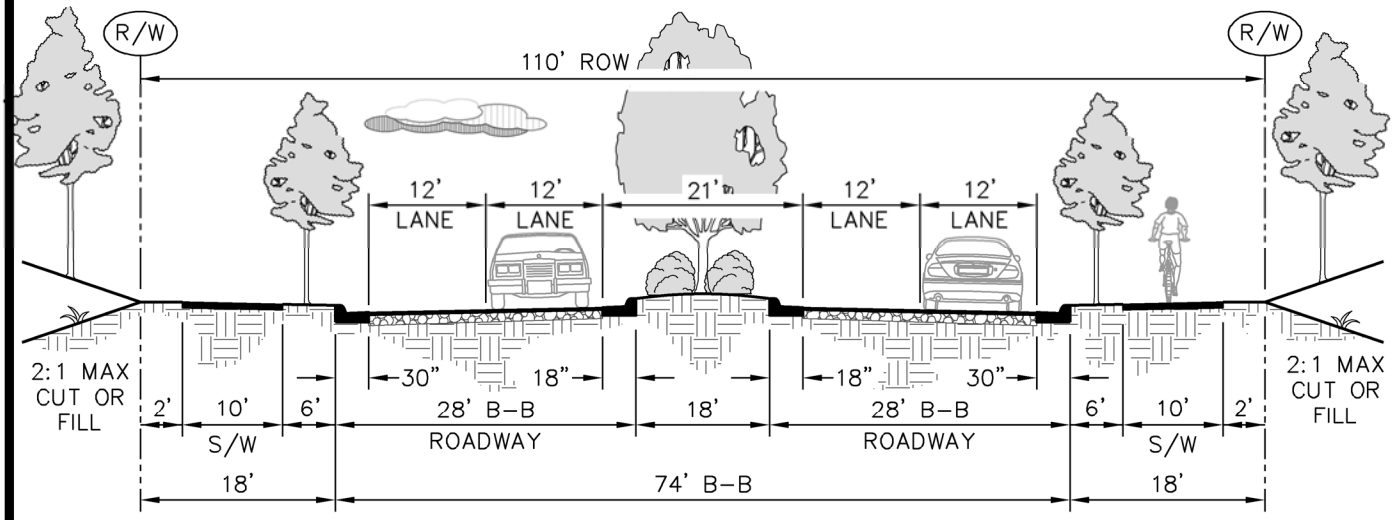
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

SCALE:	DETAIL #
Not To Scale	2401.01
REVISION DATE: December, 2022	SHEET #: 4 of 6



MAJOR THOROUGHFARE - TWO LANE DIVIDED



MAJOR THOROUGHFARE - FOUR LANE DIVIDED

NOTES:

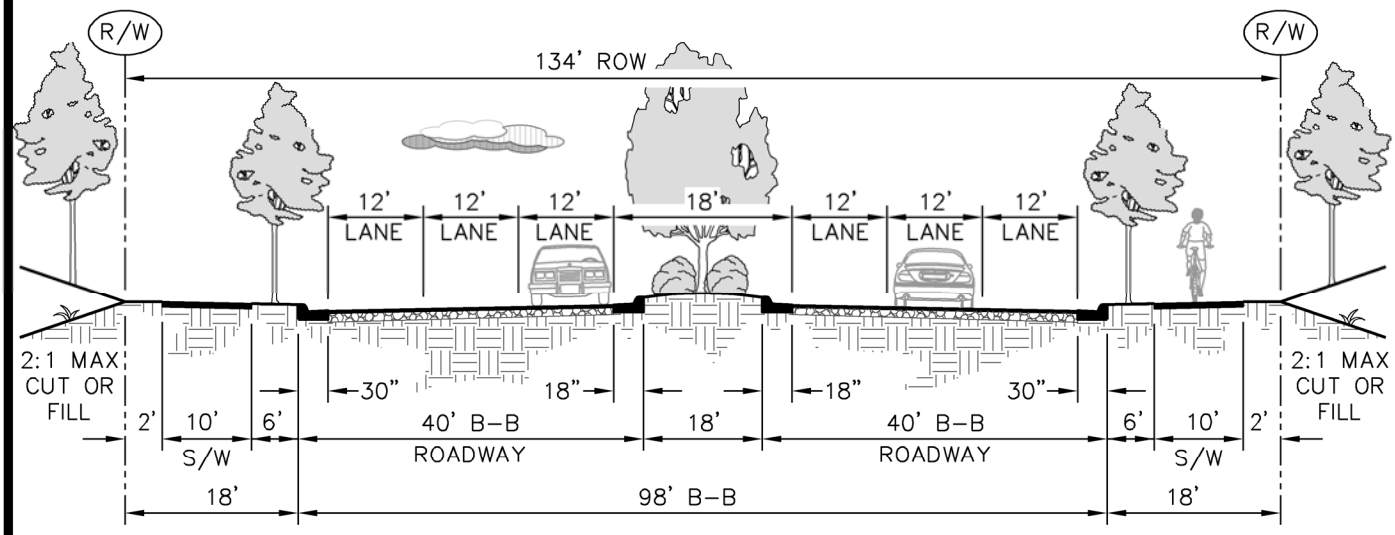
1. See sheet 1 & 2 for pavement properties & matrix.

TOWN of CLAYTON

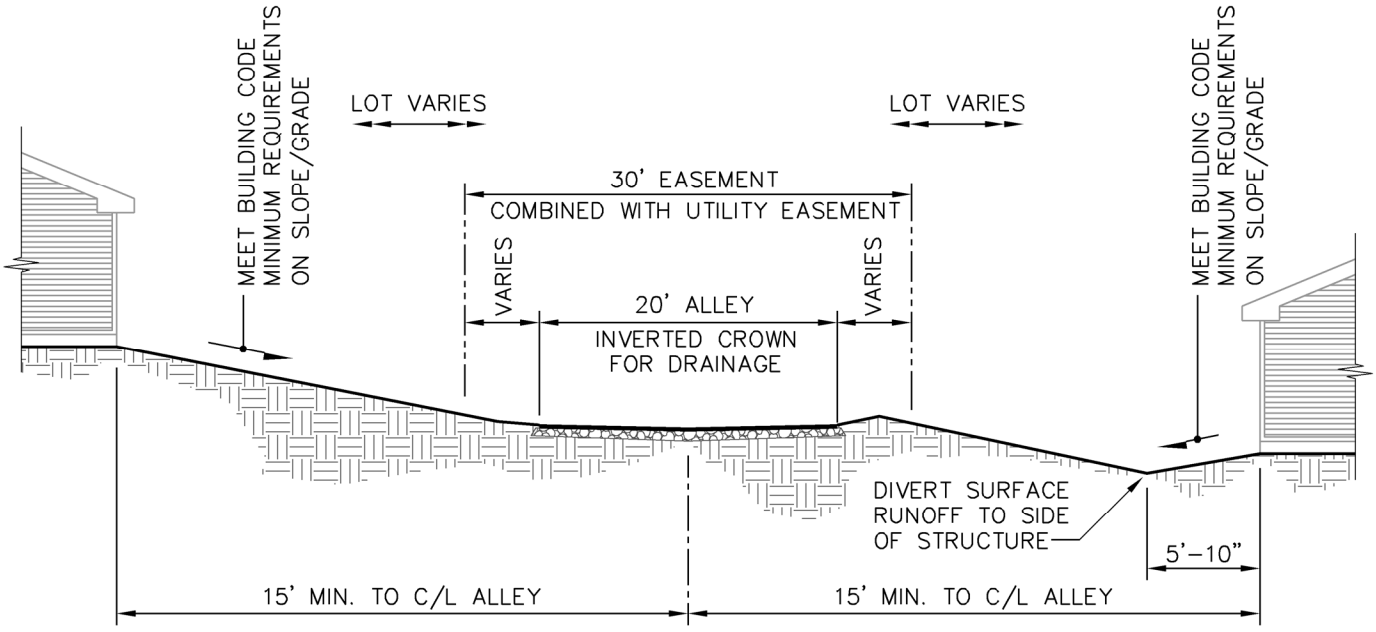
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

SCALE:	DETAIL #
Not To Scale	2401.01
REVISION DATE: December, 2022	SHEET #: 5 of 6



MAJOR THOROUGHFARE - SIX LANE DIVIDED



ALLEY

NOTES:

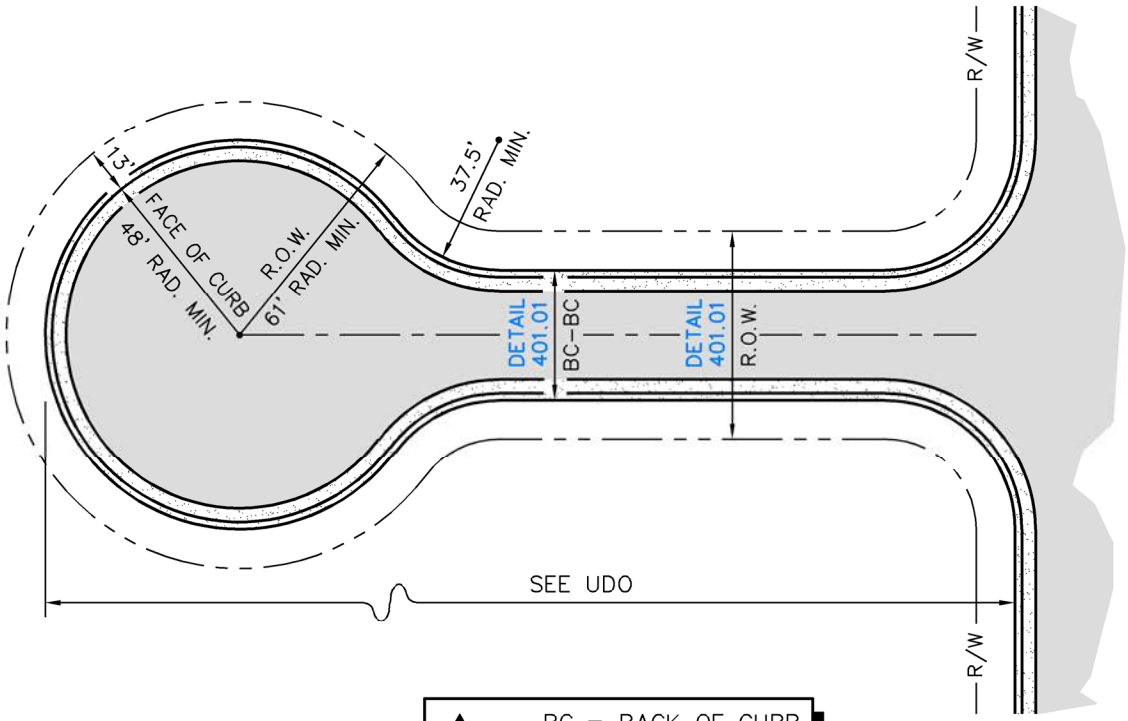
1. See sheet 1 & 2 for pavement properties & matrix.

TOWN of CLAYTON

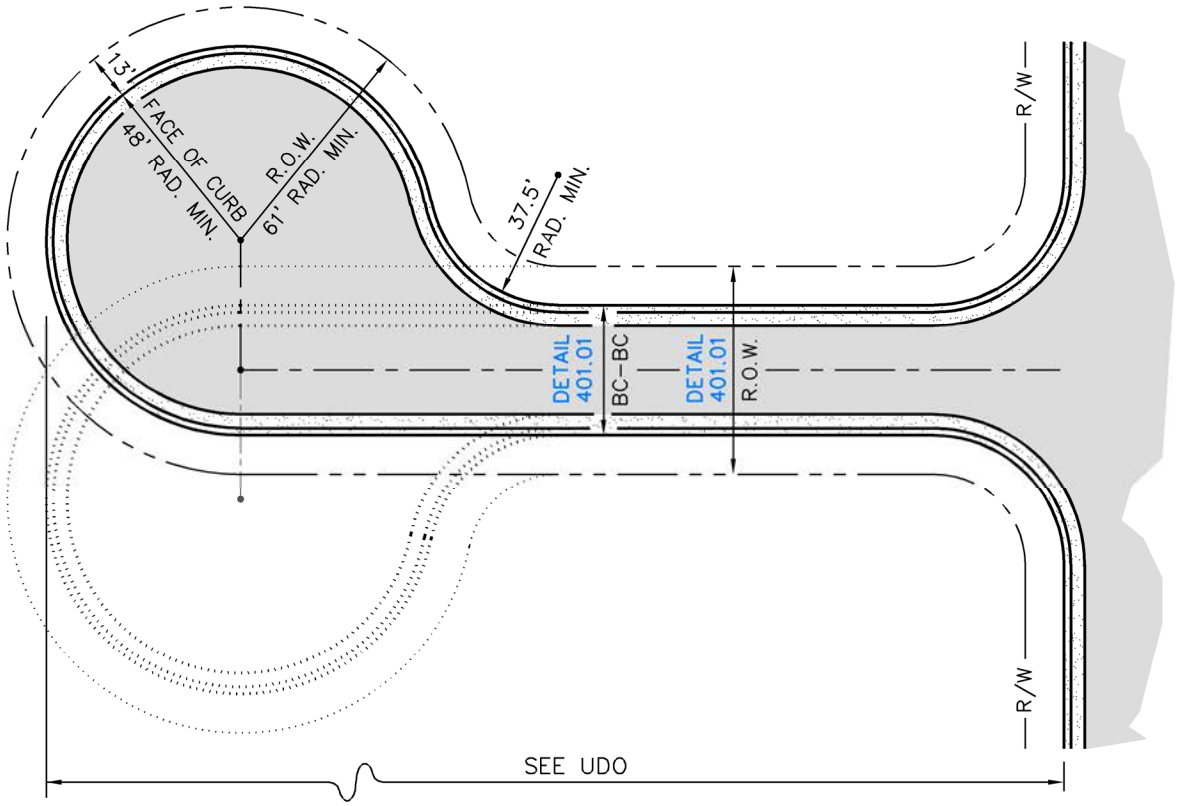
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL STREET CROSS SECTION (CURB & GUTTER APPLICATION)

SCALE:	DETAIL #
Not To Scale	2401.01
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BC = BACK OF CURB
R.O.W. = RIGHT OF WAY

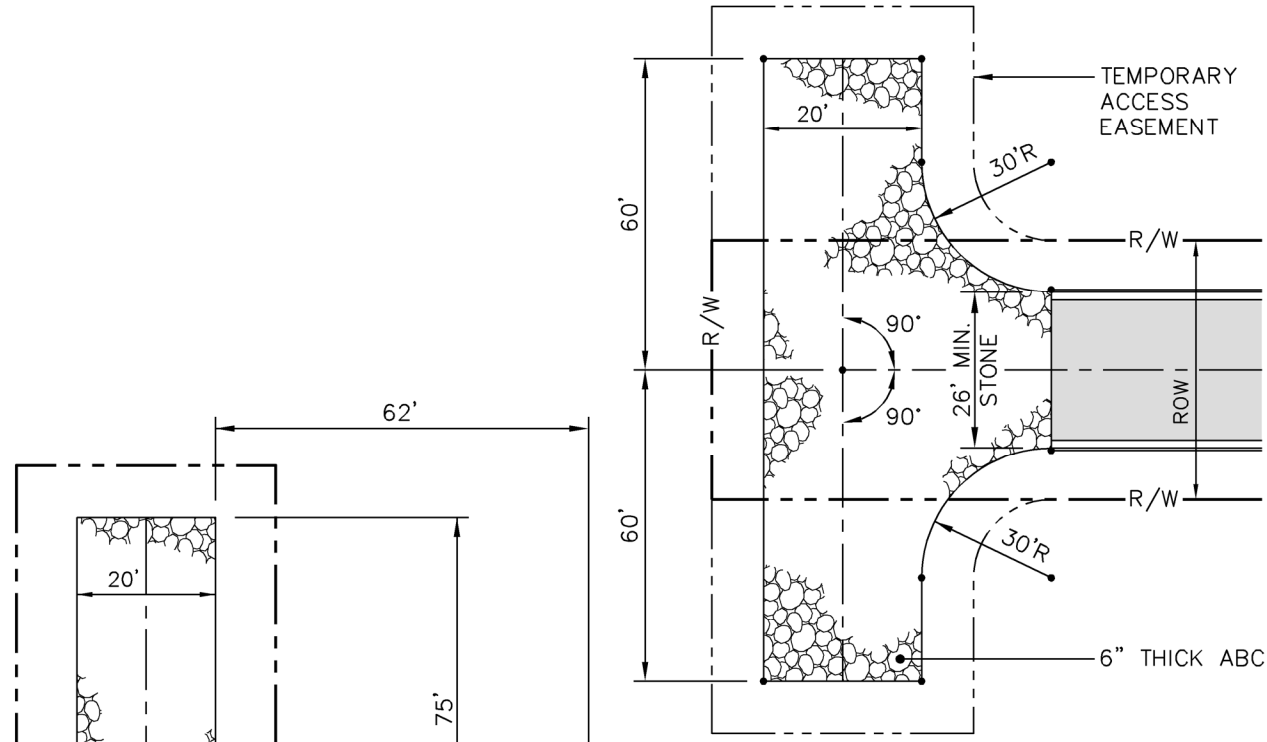


TOWN of CLAYTON

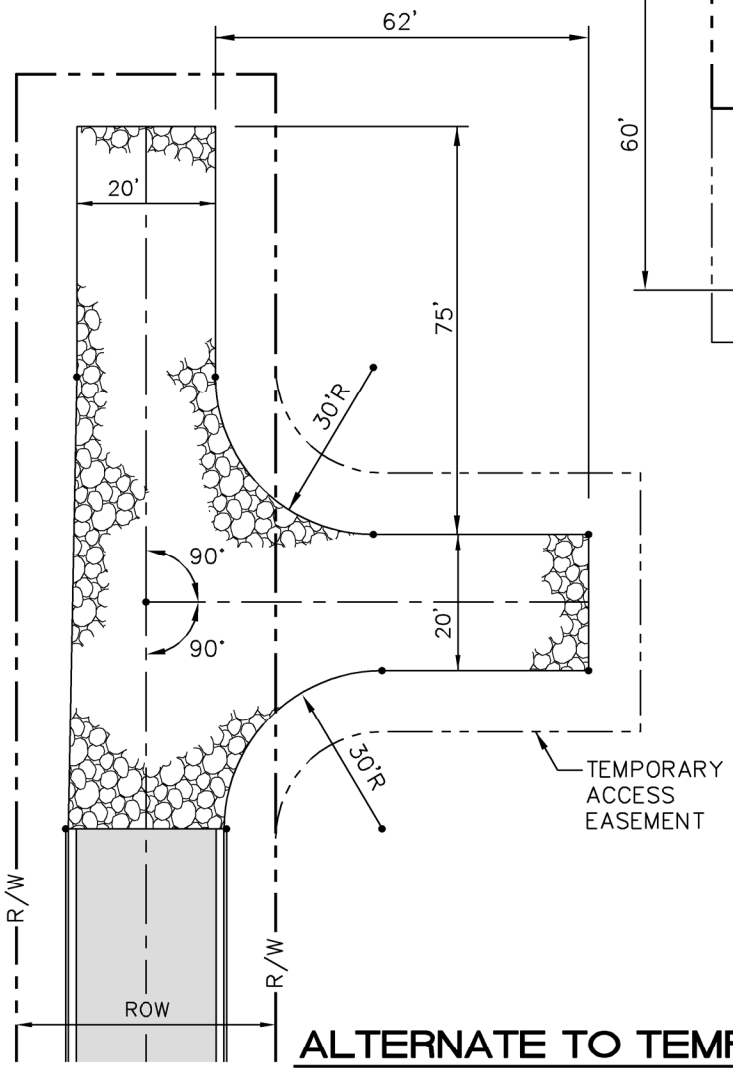
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CUL-DE-SAC DIMENSIONS RESIDENTIAL & COMMERCIAL

SCALE:	DETAIL #
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REVISION DATE: January, 2024	SHEET #: 1 of 2



TEMPORARY 120 Ft. HAMMERHEAD



ALTERNATE TO TEMPORARY 120 Ft. HAMMERHEAD

NOTES:

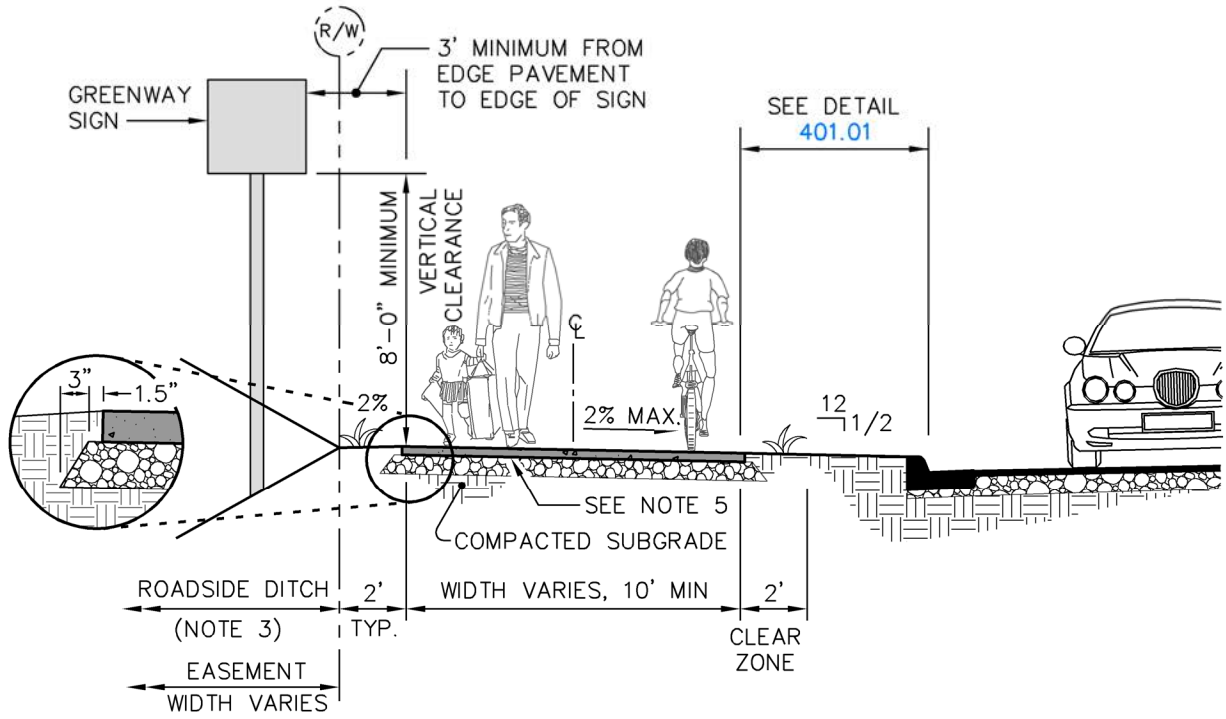
1. Modifications may be made as determined by Engineering Director.

TOWN of CLAYTON

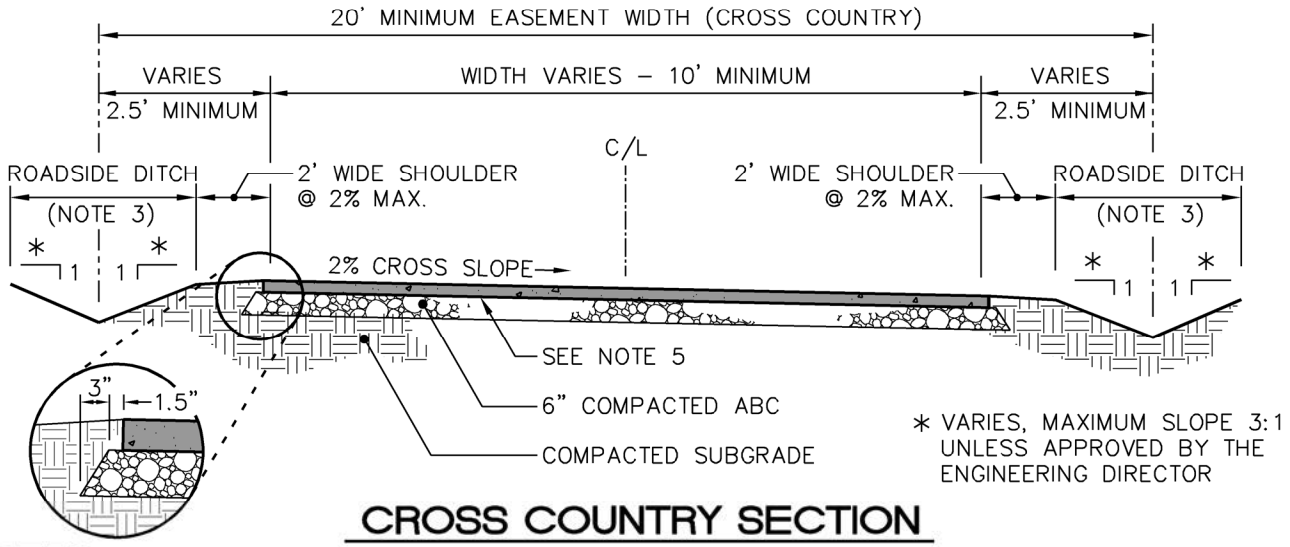
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CUL-DE-SAC DIMENSIONS RESIDENTIAL & COMMERCIAL

SCALE:	DETAIL #
Not To Scale	2401.02
REVISION DATE: January, 2024	SHEET #: 2 of 2



SECTION WITHIN STREET RIGHT OF WAY



CROSS COUNTRY SECTION

NOTES:

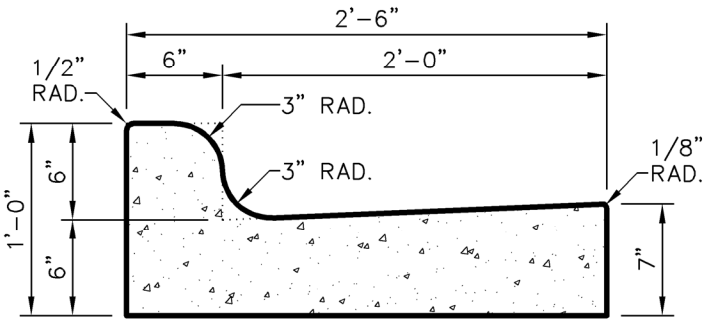
1. See detail 401.01 for road way construction / dimensions.
2. Subgrade must be compacted enough to hold up the paving operation.
3. Minimum longitudinal grade for bikeway/greenway roadside ditch = 2%
4. Minimum 30' easement if shared with utility easement.
5. Concrete pavement to be min. 4000 psi @ 28 days air entrained concrete with expansion joints and scoring per ACI 325 over minimum 4" compacted ABC base.
   Asphalt option (requires Town of Clayton Engineering Director approval)
   2 1/2" type SF 9.5A asphalt over 6" compacted ABC base.

TOWN of CLAYTON

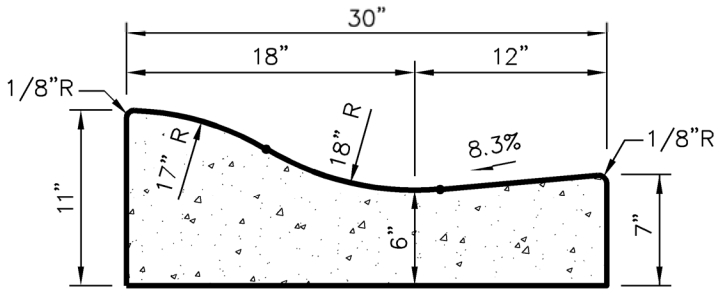
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SHARED USE PATH / GREENWAY PAVEMENT SECTION

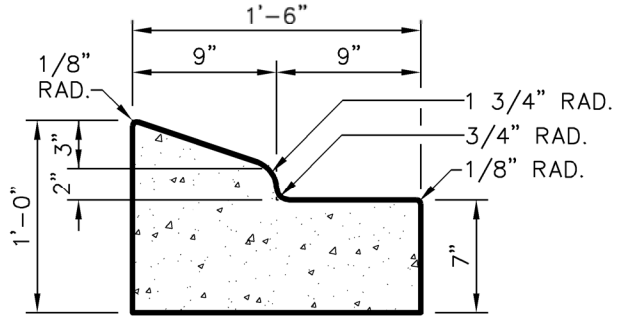
SCALE:	DETAIL #
Not To Scale	401.03
REVISION DATE: July, 2023	SHEET #: 1 of 1



STANDARD CURB AND GUTTER



ROLL TYPE CURB AND GUTTER



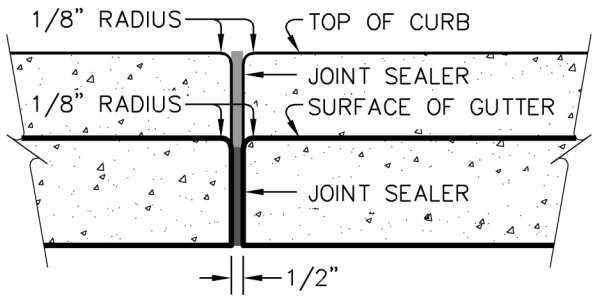
MEDIAN CURB AND GUTTER

TOWN of CLAYTON

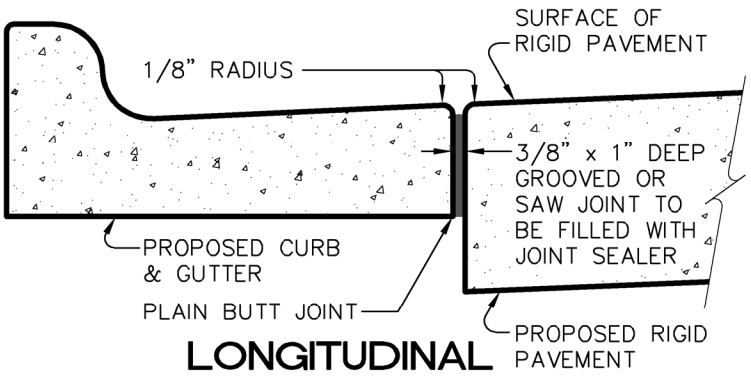
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CONCRETE CURB AND GUTTER SECTIONS

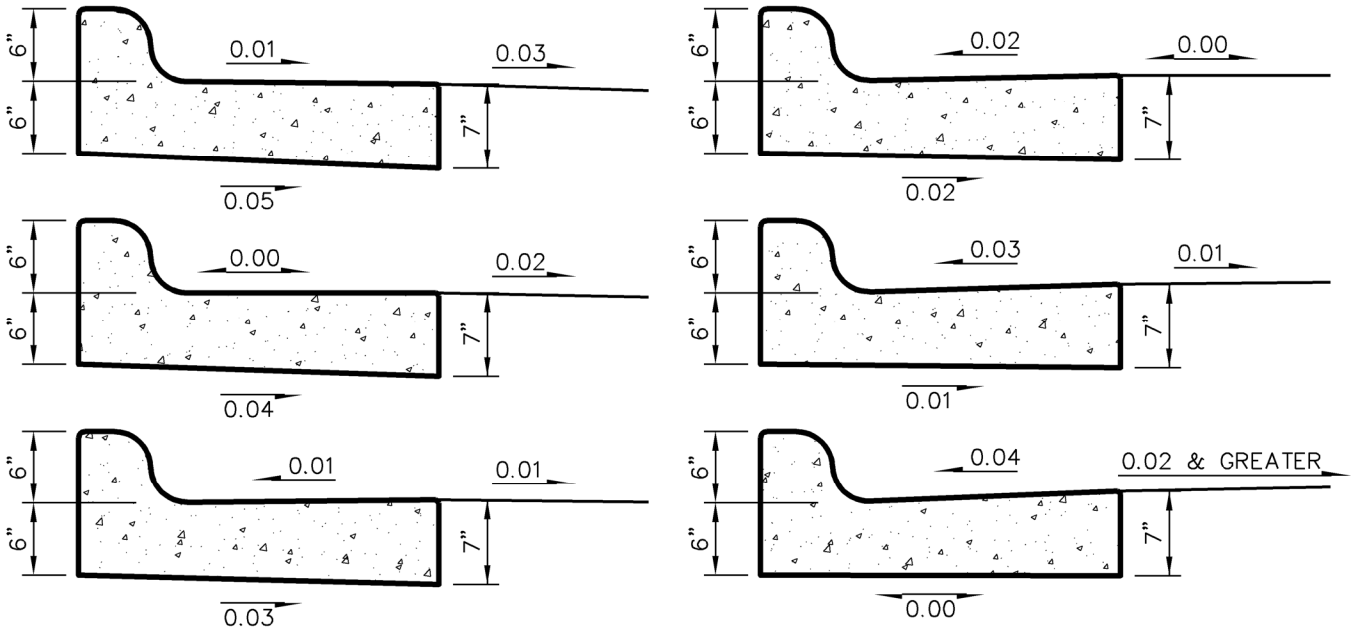
SCALE:	DETAIL #
Not To Scale	2 402.01
REVISION DATE: December, 2022	SHEET #: 1 of 2



TRANSVERSE EXPANSION JOINT IN CURB AND GUTTER



LONGITUDINAL PLAIN BUTT JOINT



SLOPES FOR VARIABLE SUPERELEVATION RATES

NOTES:

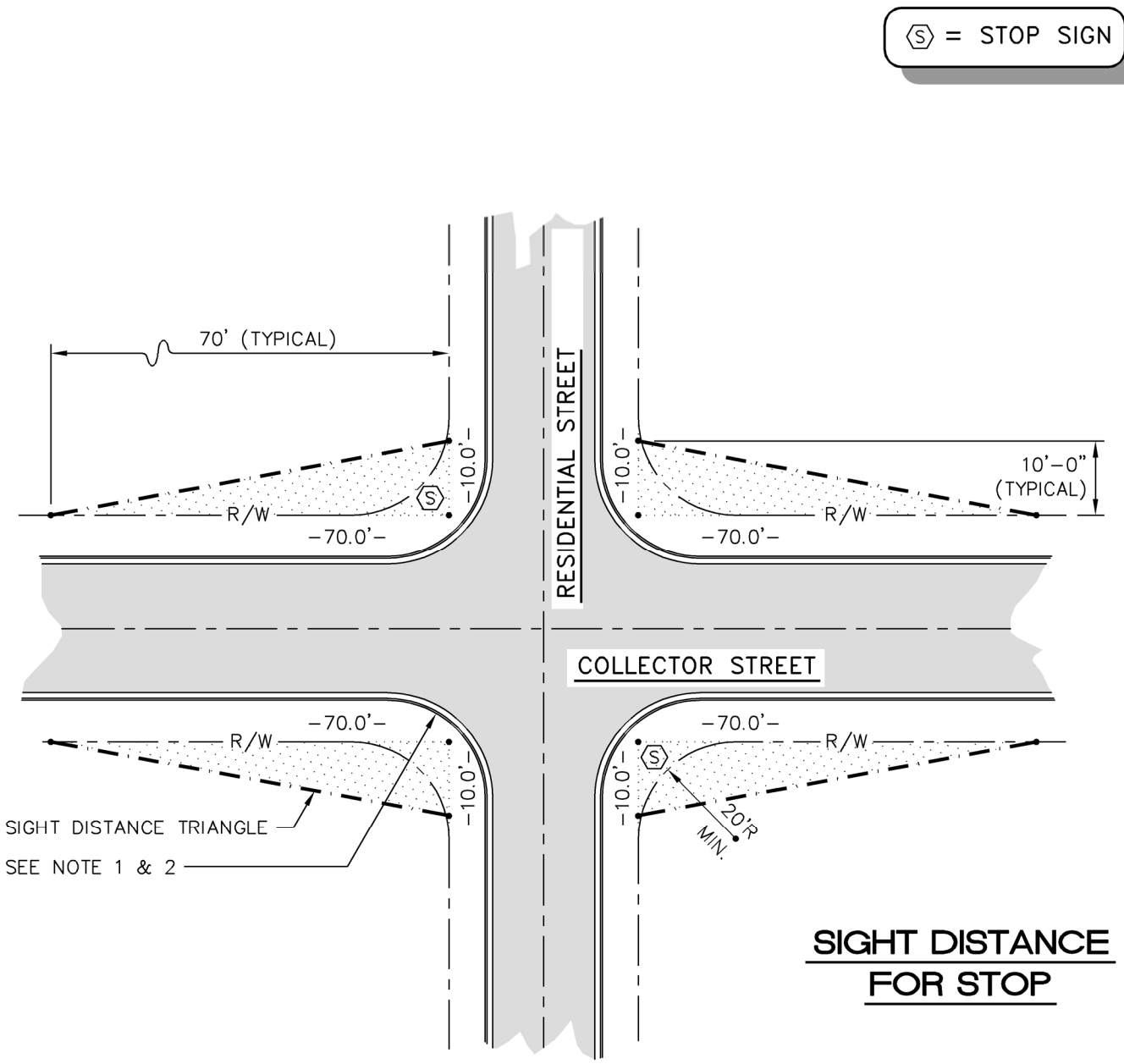
1. Contraction joints shall be placed at 10' intervals, except that a 15' spacing may be used when a machine is used.
2. Joint spacing may be altered if required by the engineer
3. Contraction joints may be installed by the use of templates or formed by other approved methods. where such joints are not formed by templates, a minimum depth of 1 1/2" shall be obtained.
4. All construction joints shall be filled with joint filler and liquid sealing and curing compound as directed by Town of Clayton Engineering Director.
5. Expansion joints shall be spaced at 90' intervals, and adjacent to all rigid objects.
6. Concrete to be a minimum of 3,000 PSI @ 28 days, air entrained.
7. Spill sections will be approved on a case–by–case basis by Town of Clayton Engineering Director.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CONCRETE CURB AND GUTTER SECTIONS

SCALE:	DETAIL #
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SIGHT DISTANCE FOR STOP

NOTES:

1. Minimum curb return radius =
   20' residential (note 2)
   30' commercial or collector street, unless otherwise directed by Engineering Director.
2. Coordinate dead end turning radius w/ Fire Marshal; 28' minimum.

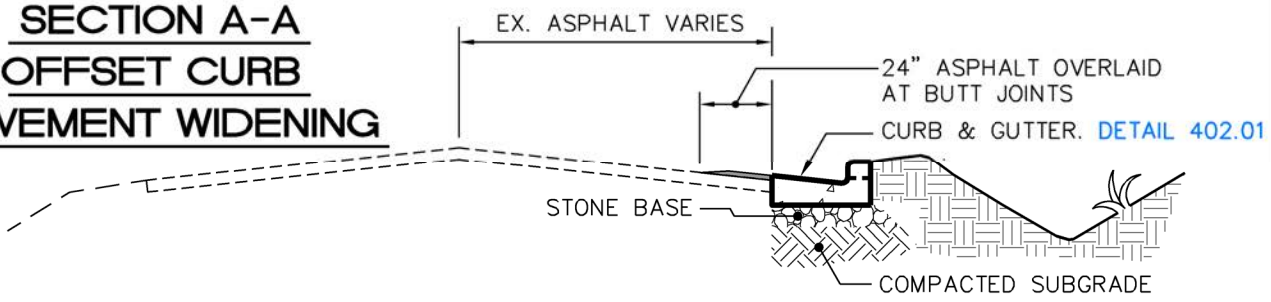
TOWN of CLAYTON

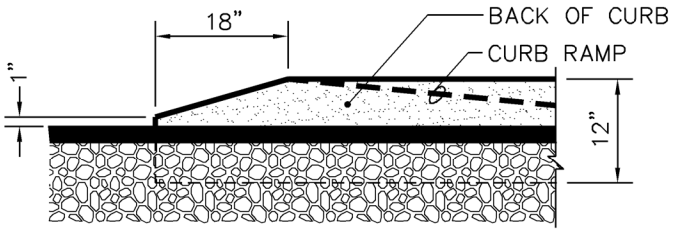
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

INTERSECTION SIGHT DISTANCE DIAGRAM (INTERSECTION OF 2 TOWN STREETS)

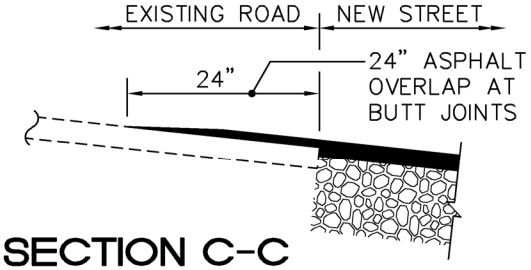
SCALE:	DETAIL #
Not To Scale	2 403.01
REVISION DATE: December, 2022	SHEET #: 1 of 1

SECTION A-A OFFSET CURB PAVEMENT WIDENING

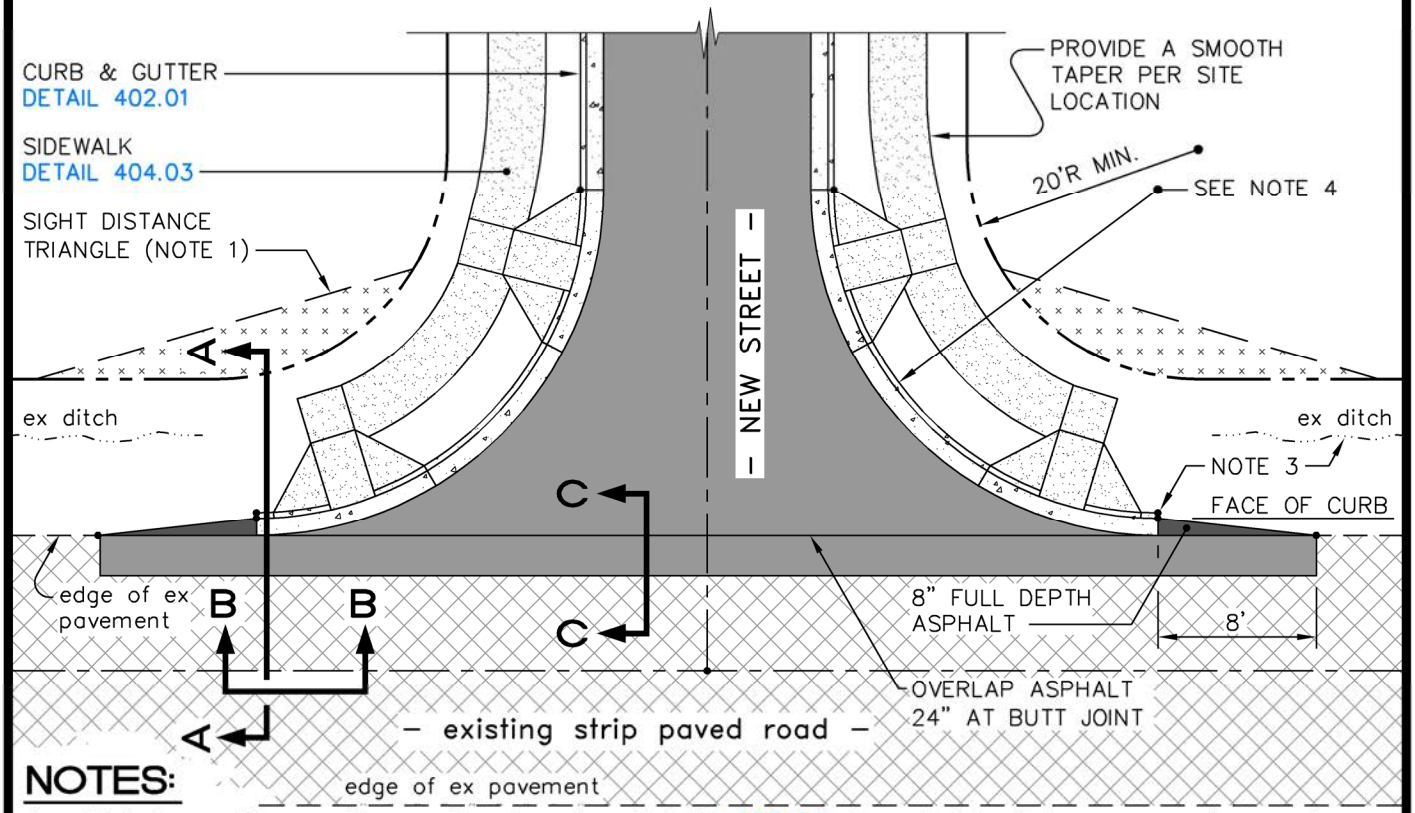




SECTION B-B CURB END TAPER



SECTION C-C



NOTES:

1. If intersecting a town street refer detail 403.01 for sight distance requirements.
2. If intersecting NCDOT roadway, refer to NCDOT Subdivision Roads Minimum Construction Standards. Latest revision, which requires curb offset.
3. Designer to address and provide erosion control measures for preventing erosion at end of curb return down to roadside ditch.
4. Minimum curb return radius = 20' residential / 30' commercial or collector street, unless directed otherwise by Engineering Director.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL TOWN C&G STREET CONNECTION to CITY or NCDOT STRIP PAVED STREET

SCALE:	DETAIL #
Not To Scale	403.02
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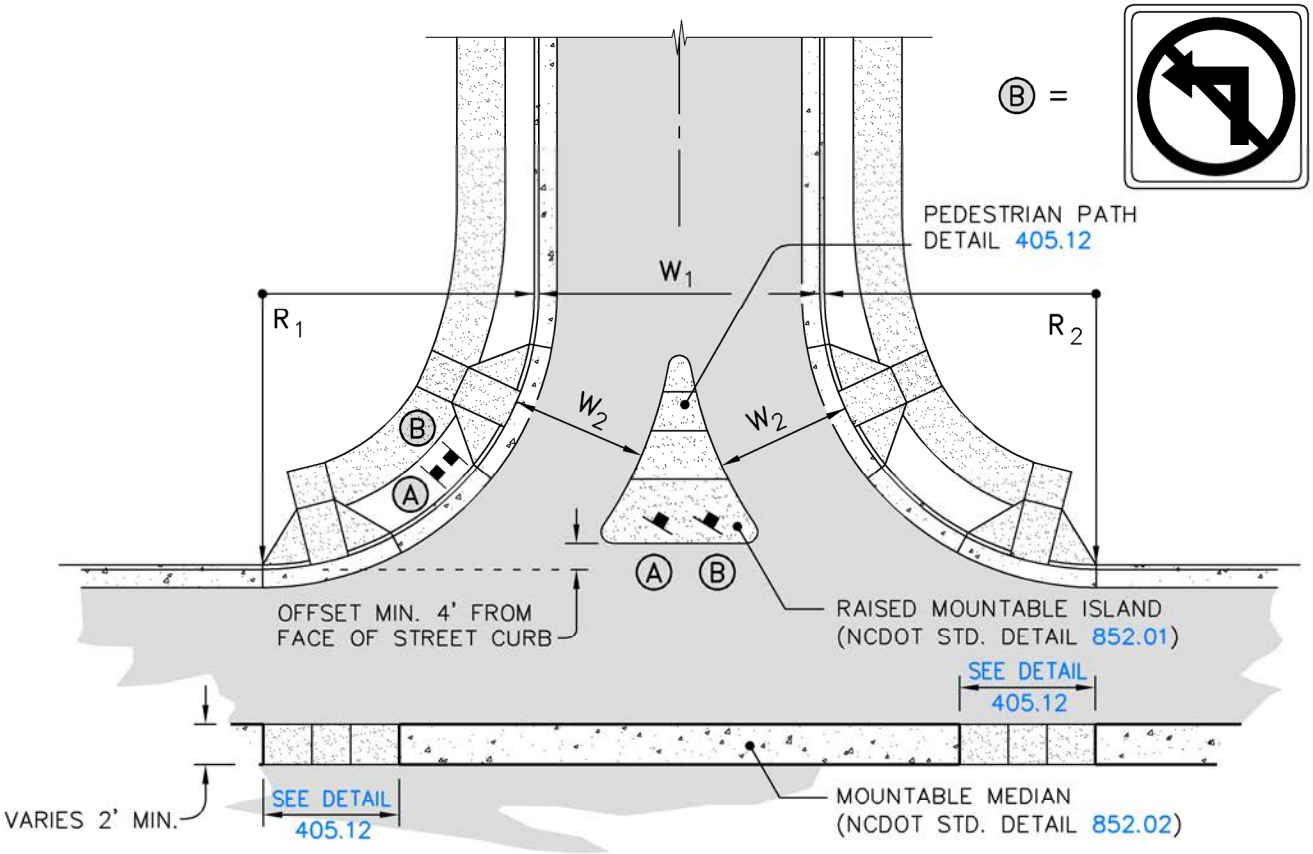
SIGN LEGEND:

Ⓐ =



Ⓑ =





CURB and GUTTER SECTION

NOTES:

1. R1/R2: As required based on vehicle path of AASHTO Design Vehicle (i.e. P, SU, WB–40, WB–50, WB–62, etc.) but no less than 50 feet (which is the minimum simple curve radius for SU Deign Vehicle). For minimum radii for other Design Vehicles, refer to AASHTO's "A Policy on Geometric Design of Highways and Streets," latest edition. Use of 3–centered compound curve radii are encouraged.
2. W1 – Drive width: Driveway width (minimum 24' of asphalt plus width of gutter on each side. For 24" curb total face to face width to be 27').
3. W2 – Lane width: Width to be determined based on vehicle path of Design Vehicle but no less than 16' face to face (SU Design Vehicle). Minimum design vehicle to be SU.
4. All dimensions subject to approval of the Engineering Director.

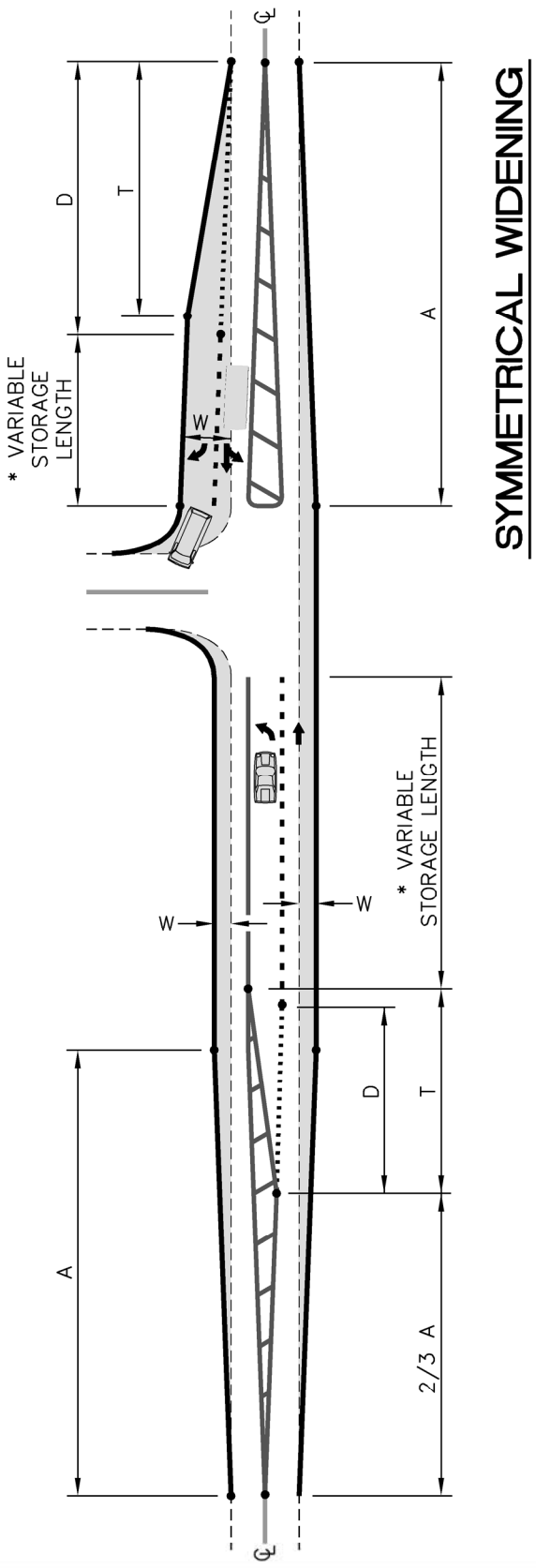
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

LEFT TURN PROHIBITION CHANNELIZATION AT DRIVEWAYS OR STREETS

SCALE:	DETAIL #
Not To Scale	2 403.03
REVISION DATE: December, 2022	SHEET #: 1 of 1

RECOMMENDED TREATMENT FOR TURN LANES – GEOMETRIC PROPERTIES					
A APPROACH – DEPARTURE	S DESIGN SPEED (mph)	W WIDTH	D MINIMUM DECELERATION LENGTH	D DESIRABLE DECELERATION LENGTH	T BAY TAPER LENGTH
REFER TO NCDOT POLICY ON STREET AND DRIVEWAY ACCESS TO NC HIGHWAYS TABLE FOR RECOMMENDED TREATMENT FOR TURN LANES FOR PARAMETERS SHOWN IN DIAGRAM.					



TOWN of CLAYTON

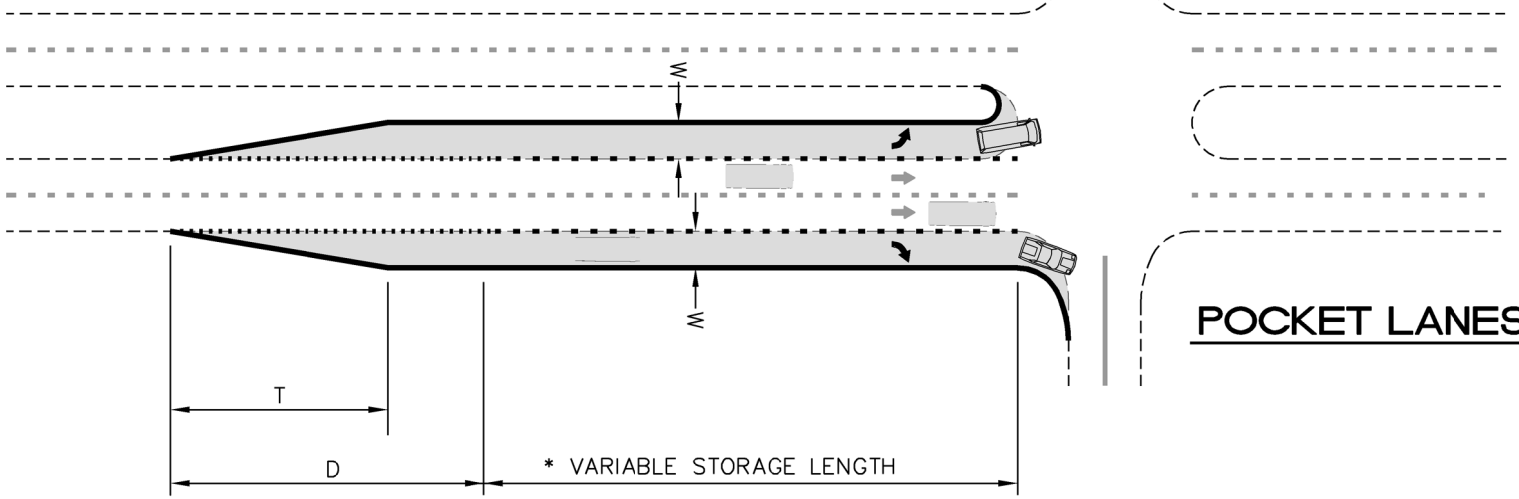
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RECOMMENDED TREATMENT FOR TURN LANES

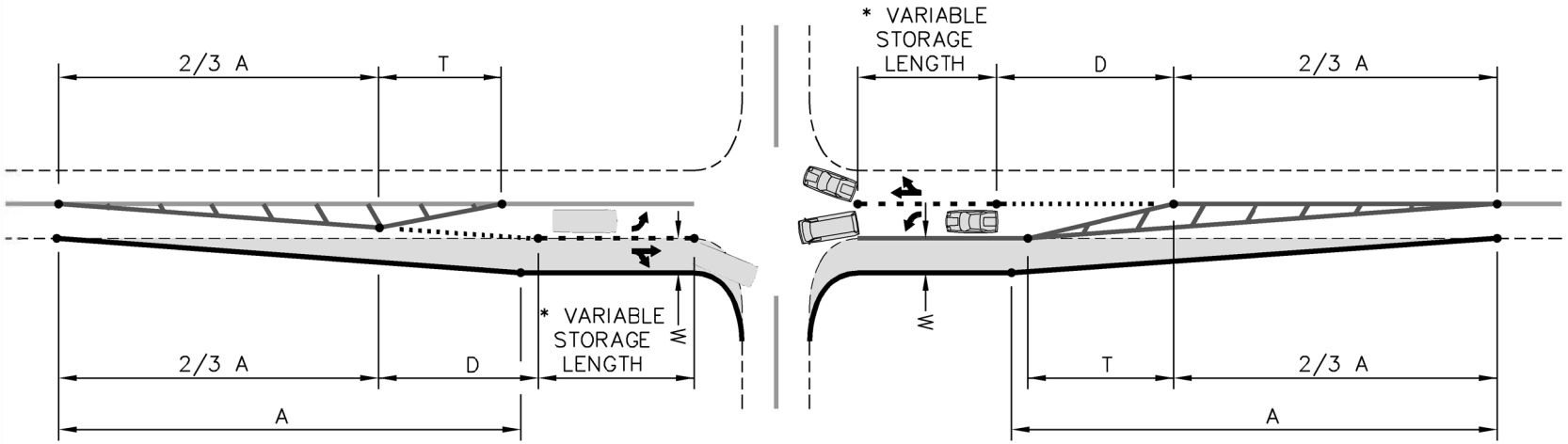
SCALE:	DETAIL #
Not To Scale	2 403.04
REVISION DATE: December, 2022	SHEET #: 1 of 2

NOTE:

REFER TO NCDOT POLICY ON STREETS & DRIVEWAY ACCESS TO NC HIGHWAYS FOR TURN LANES. PARAMETERS SHOWN IN DIAGRAMS ON THIS DETAIL.



POCKET LANES



NEAR SIDE WIDENING

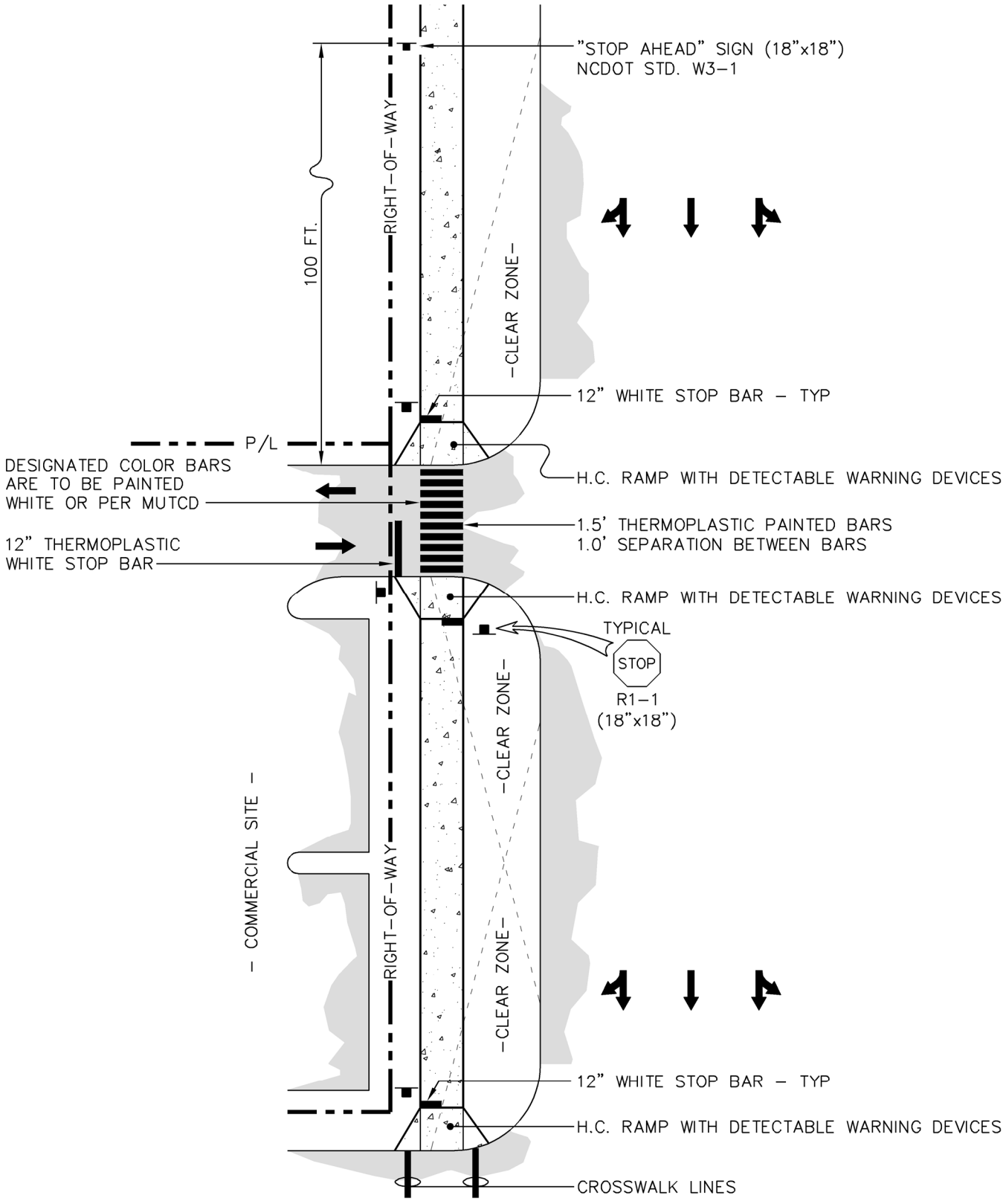
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RECOMMENDED TREATMENT FOR TURN LANES

SCALE: Not To Scale	DETAIL # 2 403.04
REVISION DATE: December, 2022	SHEET #: 2 of 2

Details Provided by APPIAN Consulting Engineers – www.appianengineers.com
11/06/2024 – 11:14:22 AM



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

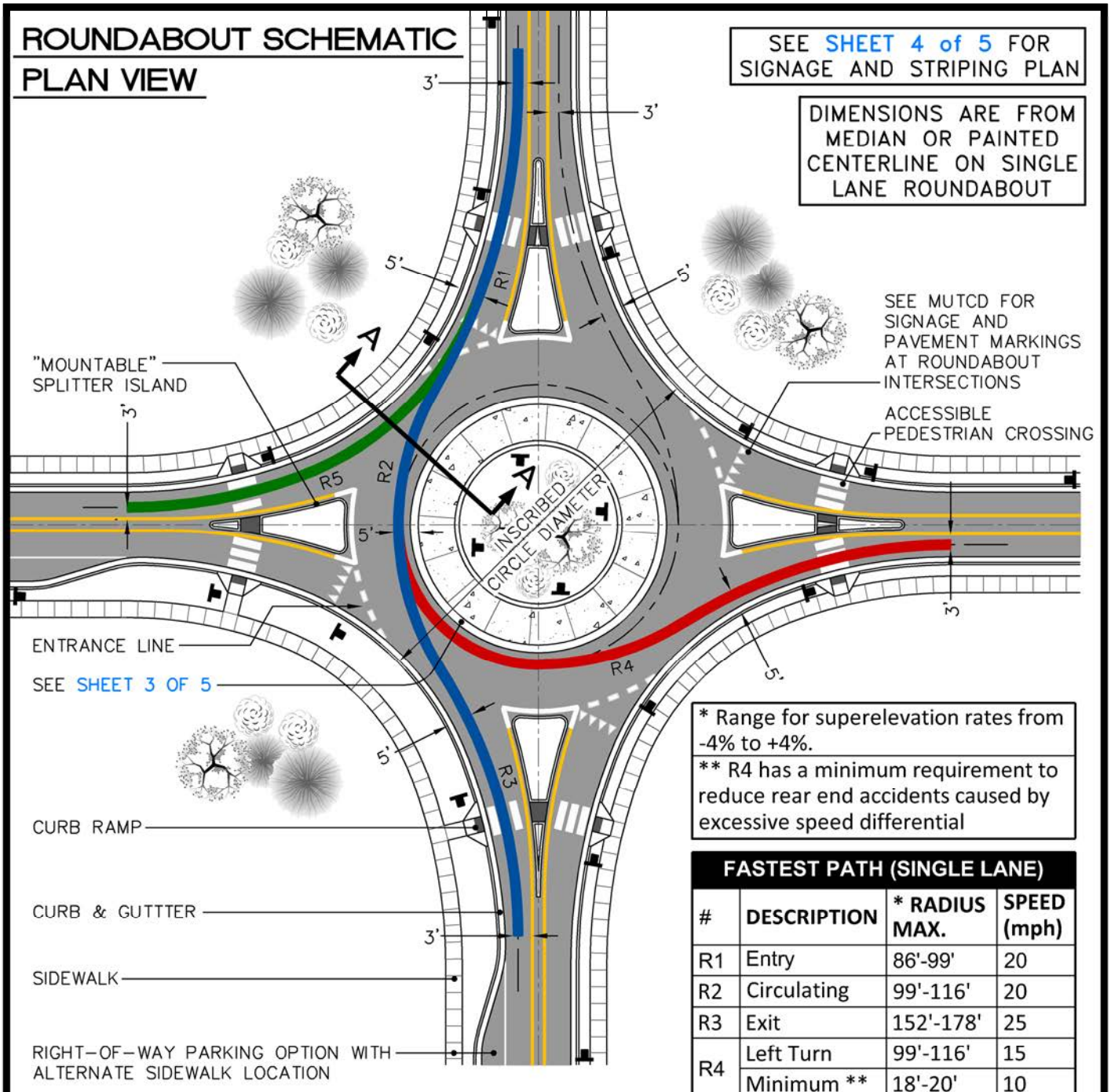
SHARED-USE PATH / GREENWAY DRIVEWAY CROSSING DETAIL

SCALE:	DETAIL #
Not To Scale	2403.05
REVISION DATE: December, 2022	SHEET #: 1 of 1

ROUNDABOUT SCHEMATIC PLAN VIEW

SEE SHEET 4 of 5 FOR SIGNAGE AND STRIPING PLAN

DIMENSIONS ARE FROM MEDIAN OR PAINTED CENTERLINE ON SINGLE LANE ROUNDABOUT



* Range for superelevation rates from -4% to +4%.

** R4 has a minimum requirement to reduce rear end accidents caused by excessive speed differential

FASTEST PATH (SINGLE LANE)			
#	DESCRIPTION	* RADIUS MAX.	SPEED (mph)
R1	Entry	86'-99'	20
R2	Circulating	99'-116'	20
R3	Exit	152'-178'	25
R4	Left Turn	99'-116'	15
	Minimum **	18'-20'	10
R5	Right Turn	152'-178'	20

NOTES:

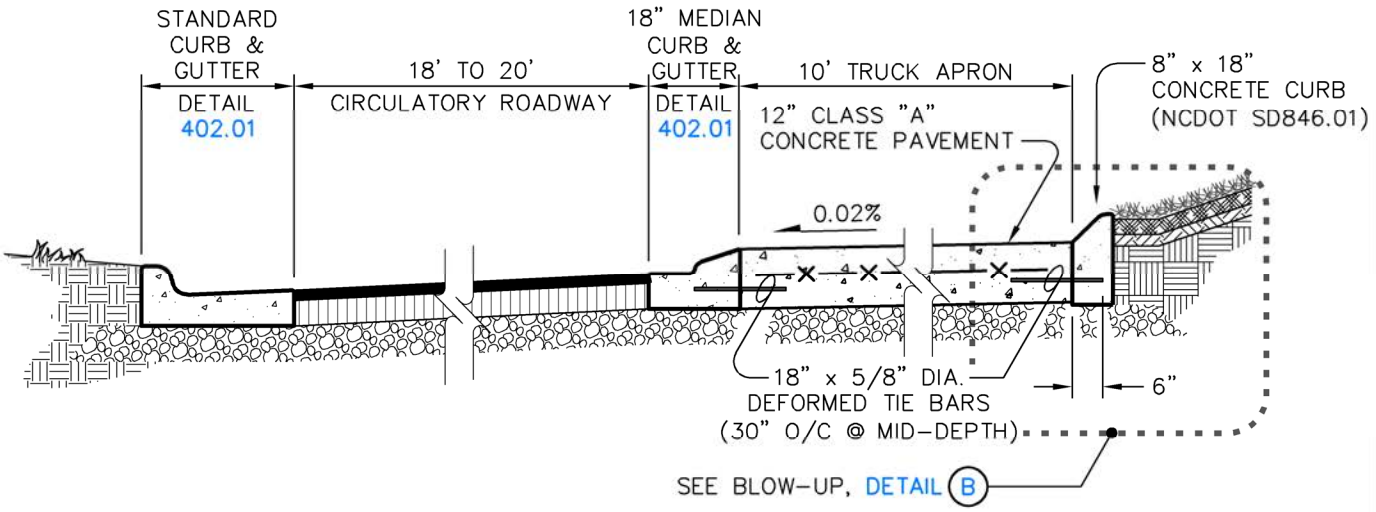
1. Decision Sight Distance (DSD) and Stopping Sight Distance (SSD) must be checked for horizontal and vertical alignment. DSD & SSD are measured along vehicle path.
2. SSD for pedestrians measured to point 6' behind curb.
3. Refer to the FHWA Technical Summary on Roundabouts for considerations in the design section & implementation of Roundabouts (FHWA-SA-10-006, latest revision).

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE LANE ROUNDABOUT TRAFFIC CIRCLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 403.06
REVISION DATE: July, 2023	SHEET #: 1 of 5



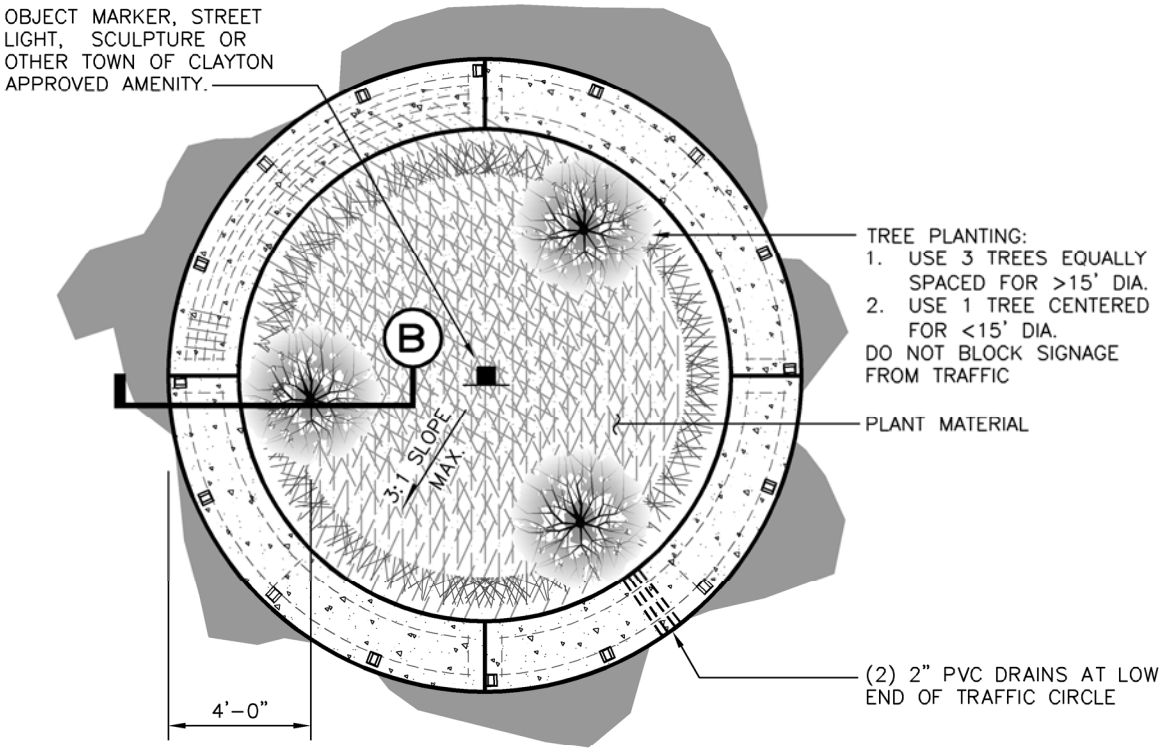
ROAD CROSS SECTION A-A

TOWN of CLAYTON

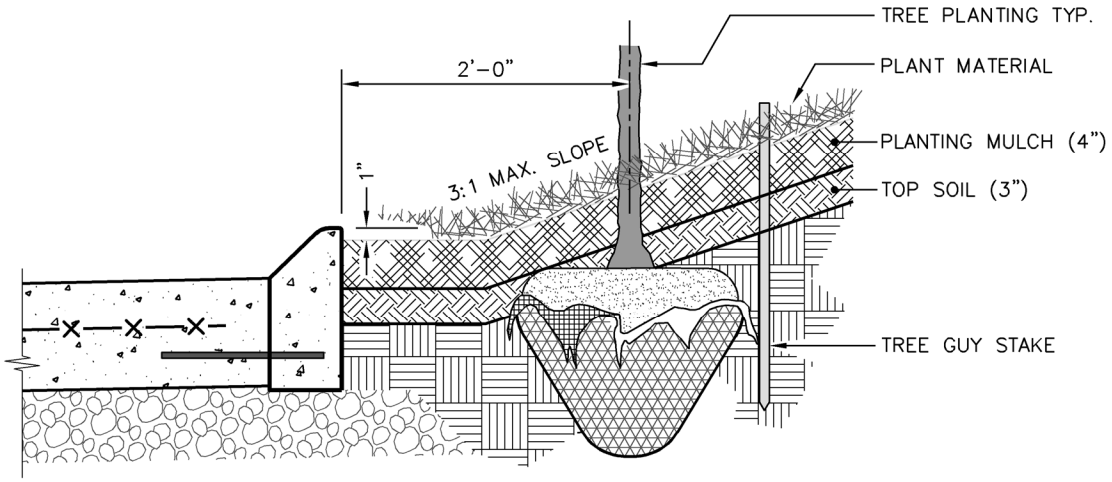
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE LANE ROUNDABOUT TRAFFIC CIRCLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 403.06
REVISION DATE: July, 2023	SHEET #: 2 of 5



PLAN VIEW OF TRAFFIC CIRCLE LANDSCAPING



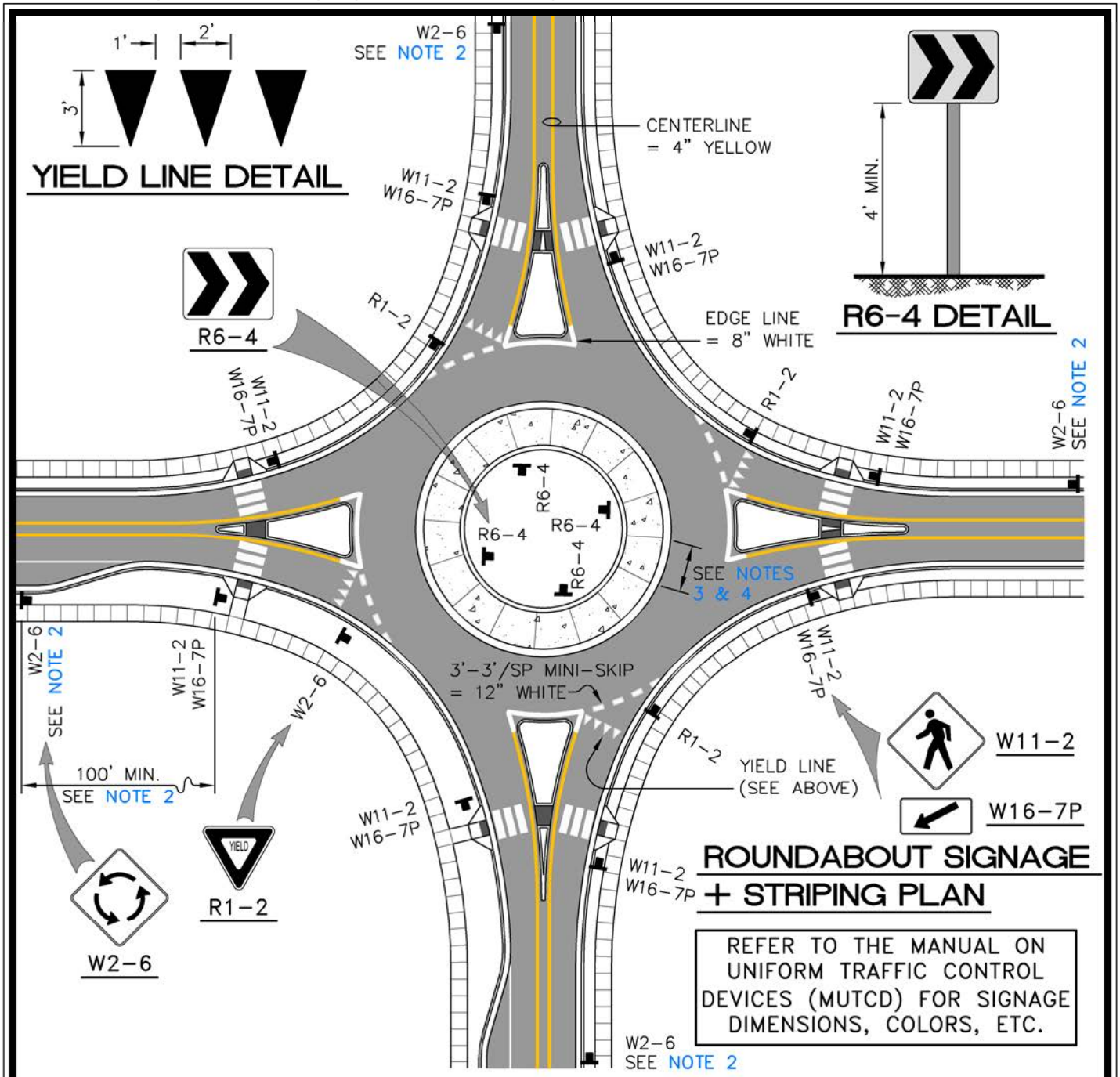
B LANDSCAPING DETAIL

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE LANE ROUNDABOUT TRAFFIC CIRCLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 403.06
REVISION DATE: December, 2022	SHEET #: 3 of 5



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE LANE ROUNDABOUT TRAFFIC CIRCLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 403.06
REVISION DATE:	SHEET #:
July, 2023	4 of 5

NOTES:

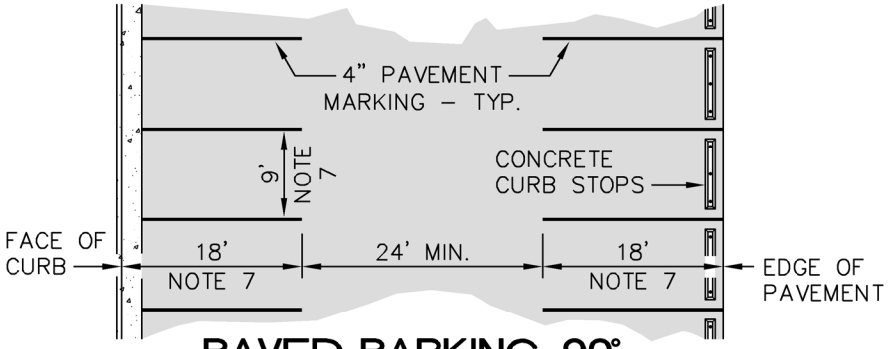
1. Provide signing & pavement markings on each leg of approach
2. Install warning sign if posted speed limit is 40 MPH or higher. Place warning sign to provide 180' feet minimum visibility distance. If sign visibility is obstructed, place sign in advance of obstruction.
3. Outside chord spacing of truck apron transverse contraction joints to be equally spaced and placed at a maximum of 1.5 times apron width but no more than 15 feet on center. Contraction joints are to be sawed to a minimum depth of 3 inches, sealed, and doweled as shown on the applicable sawed joint on NCDOT Standard Detail 700.01.
4. See NCDOT Standard Detail 700.02 for detailing of a planned expansion joint.
5. Welded wire fabric is not generally recommended to be used for concrete pavement truck aprons due to constructability issues. Curved longitudinal #5's bars at 12 inches o/c placed in the top 1/3 of slab with a minimum of 2 inches of cover is preferred (meets minimum 0.002 times area of apron requirement).
6. Lap transverse edges of sheets of welded wire fabric, if used, 12 inches except at transverse expansion joints.

TOWN of CLAYTON

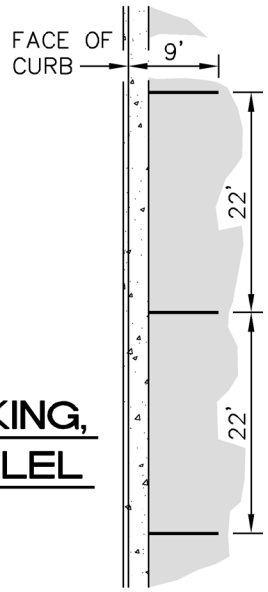
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE LANE ROUNDABOUT TRAFFIC CIRCLE DETAIL

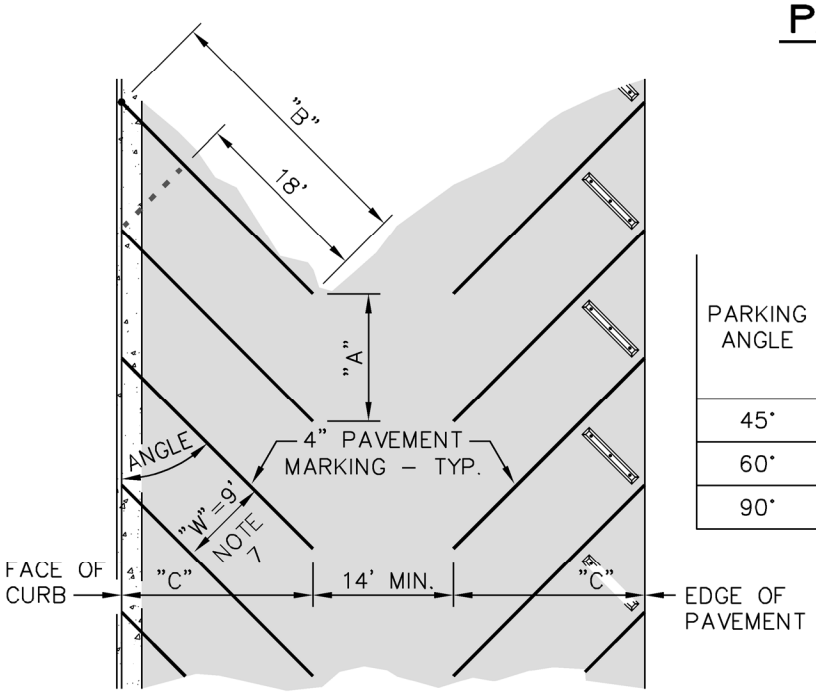
SCALE:	DETAIL #
Not To Scale	2 403.06
REVISION DATE: July, 2023	SHEET #: 5 of 5



PAVED PARKING, 90°



PAVED PARKING, PARALLEL



PARKING ANGLE	"W" STALL WIDTH	"A" STALL WIDTH AT PARKING ANGLE	"B" STALL DEPTH AT PARKING ANGLE	"C" STALL DEPTH
45°	9'	12.73'	27'	19.1'
60°	9'	10.4'	23.2'	20.1'
90°	9'	9'	18'	18'

PAVED PARKING, 45° and 60°

NOTES:

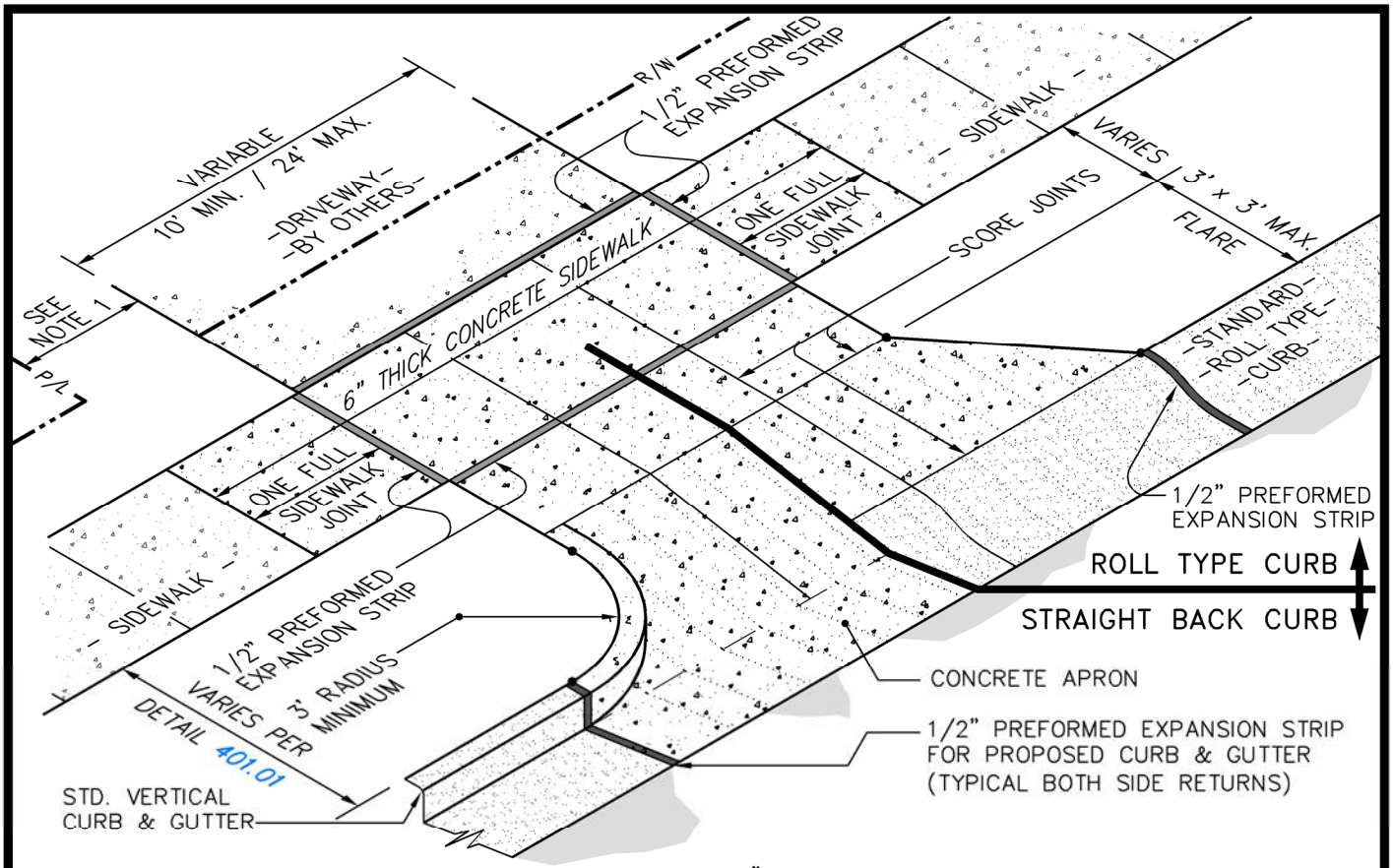
1. Concrete stop not required if curb is used. If sidewalk is against back of curb, a minimum 6' width is required without curb stops.
2. Number of required parking spaces is listed in Chapter 9 of the UDO.
3. Number of required ADA spaces for paved parking areas are listed in the current NC building Code.
4. Add ADA parking spaces mush directly connect to public access routes that meet ADA requirements.
5. ADA parking spaces must meet ADA dimensions.
6. All regulatory pavement markings shall be thermoplastic, including crosswalks, stop bars, and directional arrows.
7. If compact spaces are utilized, standard parking dimensions may be reduced to a width of 8' and a length of 16'.

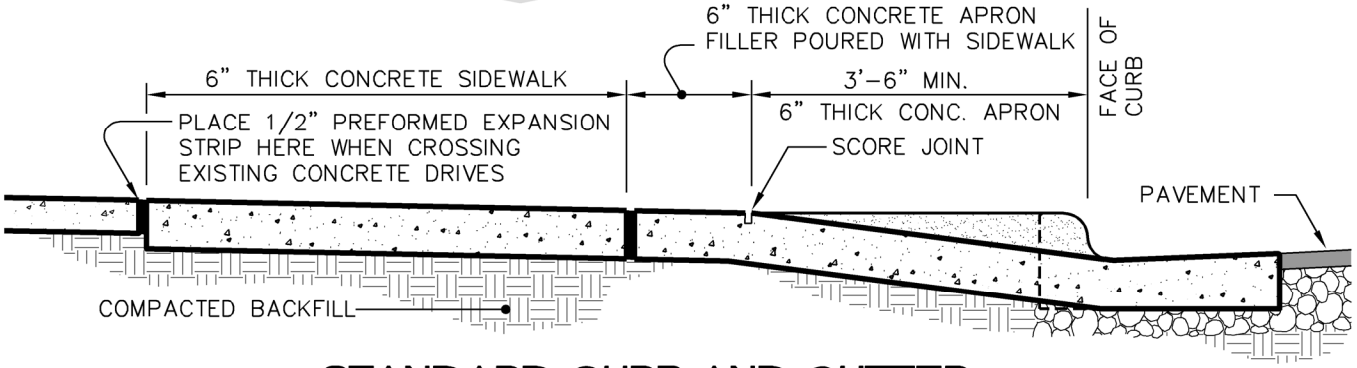
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

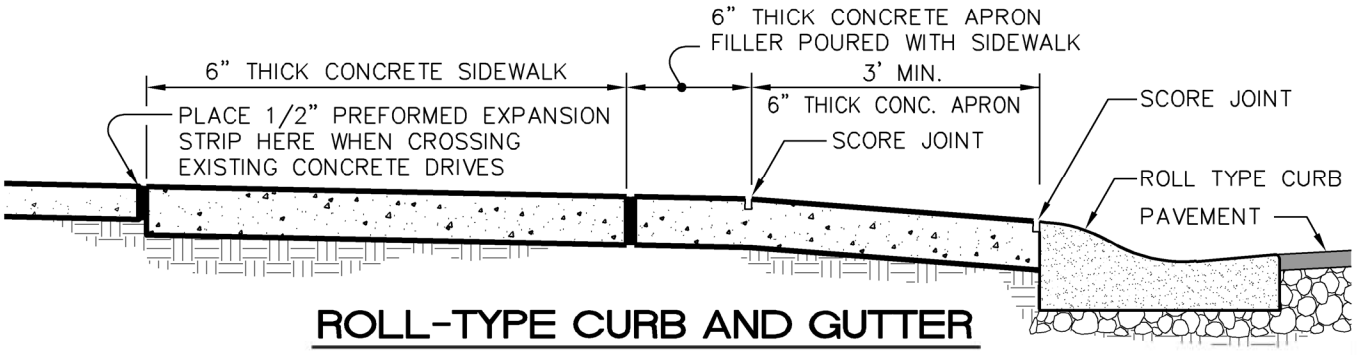
OFF STREET PARKING STALL LAYOUT

SCALE:	DETAIL #
Not To Scale	2403.07
REVISION DATE: December, 2022	SHEET #: 1 of 1





STANDARD CURB AND GUTTER



ROLL-TYPE CURB AND GUTTER

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RESIDENTIAL DRIVEWAY CONNECTION

SCALE:	DETAIL #
Not To Scale	2 404.01
REVISION DATE:	SHEET #:
July, 2023	1 of 2

NOTES:

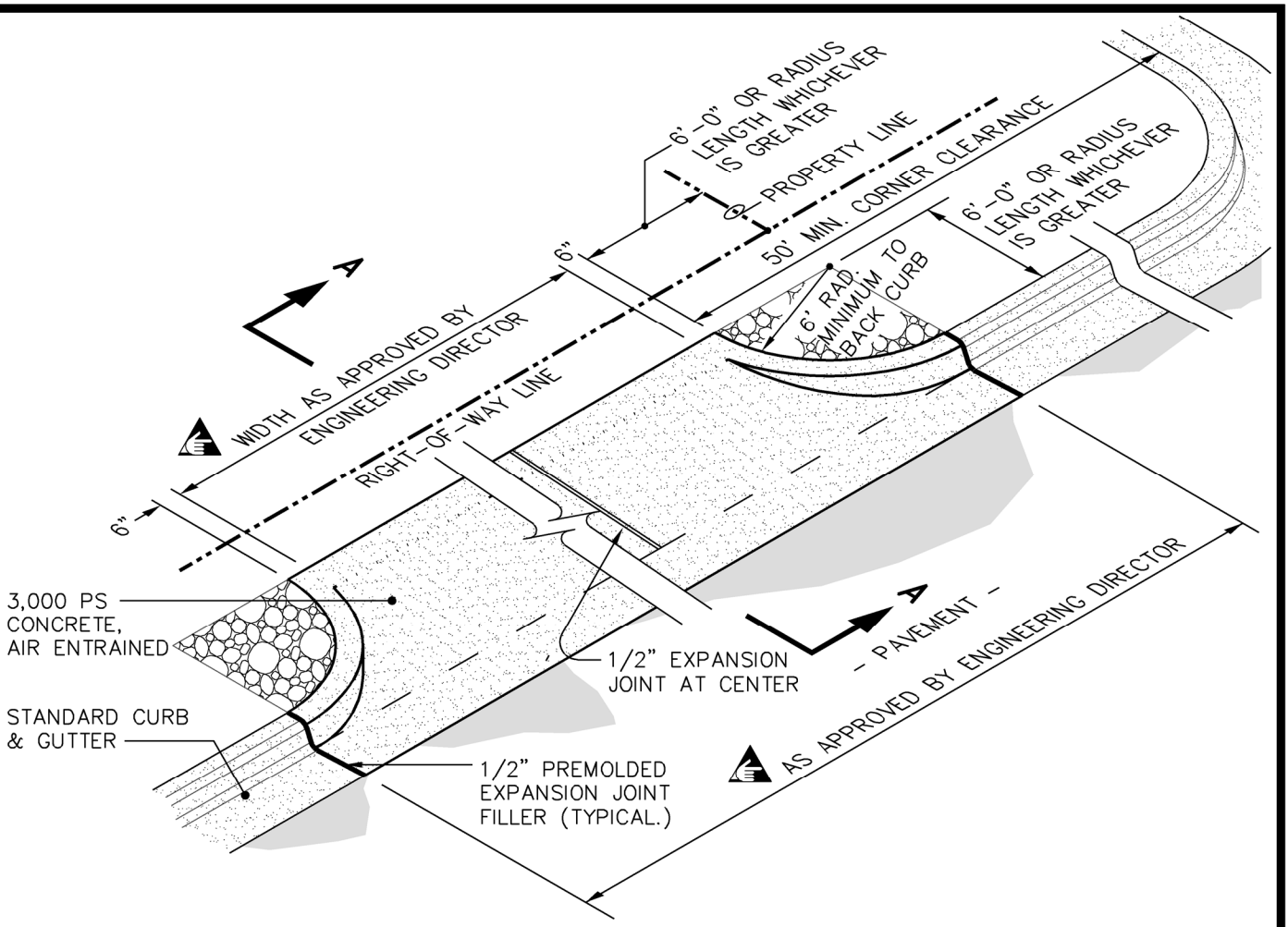
1. The min. corner clearance from the curb line or edge of pavement of the intersecting streets shall be at least 20' from the PT of the radius curvature or 20' from the intersection of the right–of–way lines; whichever is greater and no closer than 3.5' min. to any lot line.
2. Entire entrance including gutter and apron shall be poured monolithically.
3. Width of curb & gutter shall match width of existing curb & gutter.
4. Street type driveways are permitted.

TOWN of CLAYTON

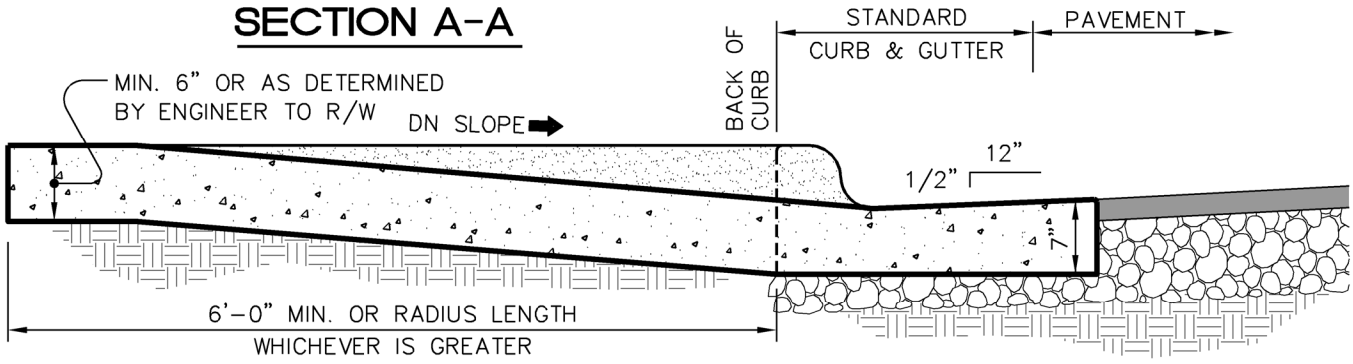
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RESIDENTIAL DRIVEWAY CONNECTION

SCALE:	DETAIL #
Not To Scale	2 404.01
REVISION DATE: December, 2022	SHEET #: 2 of 2



SECTION A-A



NOTES:

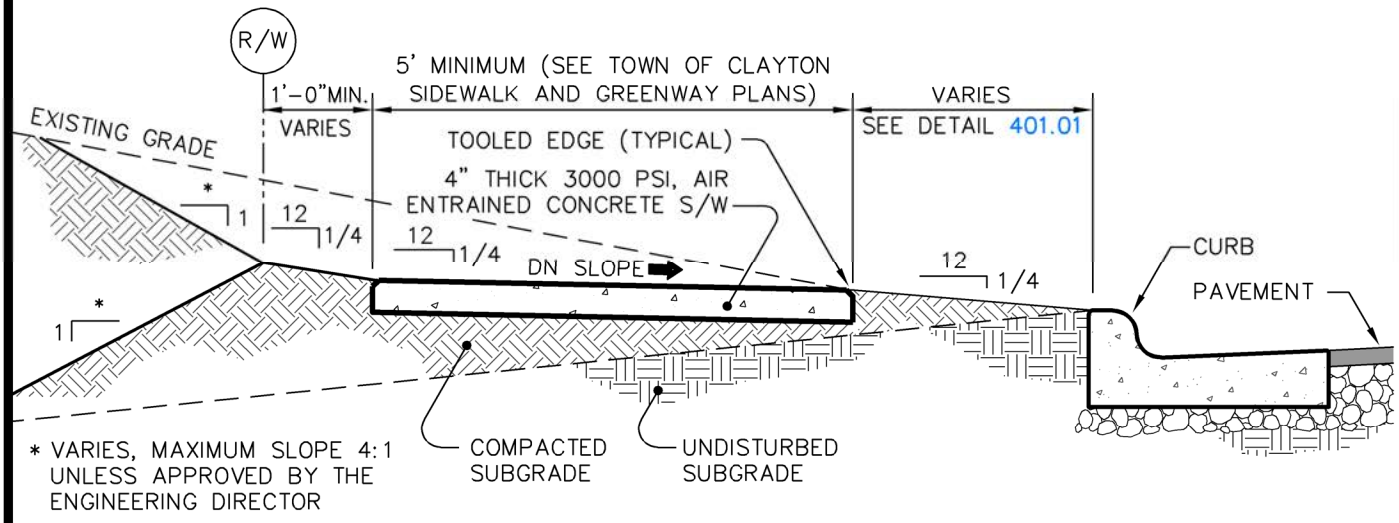
1. Drive to be minimum 50' from PT of intersection & 12' minimum from a property line.
2. Entire entrance including gutter and apron shall be poured monolithically.
3. Width of curb & gutter shall match width of existing curb & gutter.
4. Street type driveways are permitted.
5. Entrance width and radius shall be sized to accommodate turning radius of proposed trucks to/from site development.

TOWN of CLAYTON

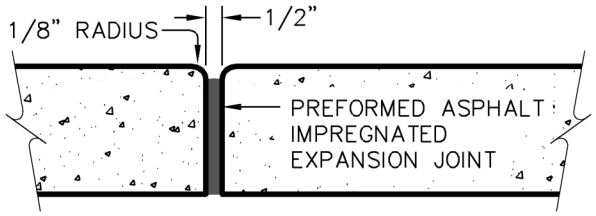
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

COMMERCIAL CONCRETE DRIVEWAY CONNECTION

SCALE:	DETAIL #
Not To Scale	2 404.02
REVISION DATE: December, 2022	SHEET #: 1 of 1



TYPICAL SIDEWALK with UTILITY STRIP



TYPICAL EXPANSION JOINT DETAIL

NOTES:

1. Provide 1" deep tooled traverse structural score joint with 1/8" radius at 5'–0" o.c.
2. 1/2" preformed asphalt impregnated expansion strip joints to be placed 40'–0" o.c. longitudinally, adjacent to curbs, when butting existing structures, concrete, or buildings, and at changes in width.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL CONCRETE SIDEWALK AND EXPANSION JOINT DETAIL

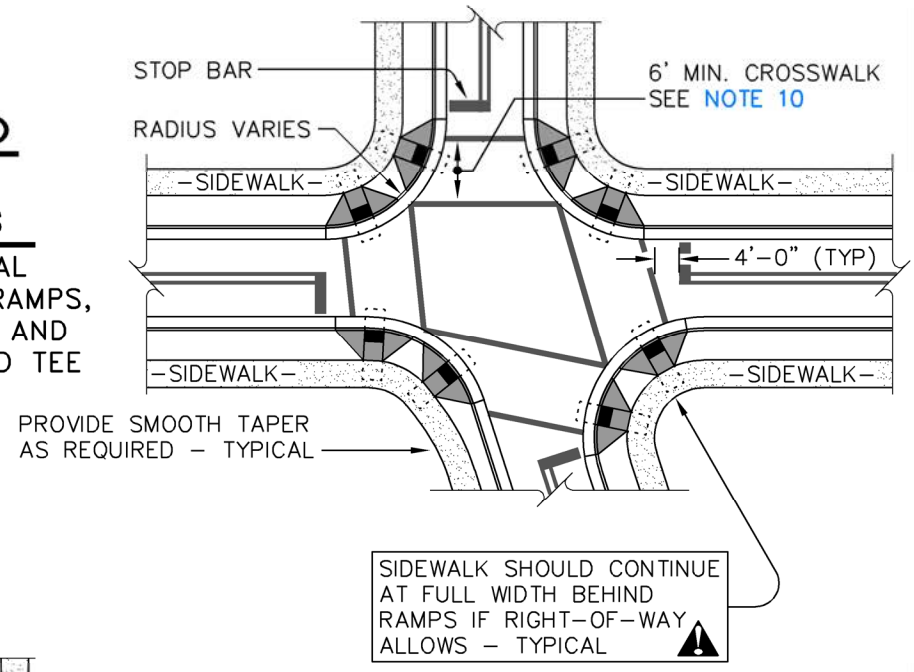
SCALE:	DETAIL #
Not To Scale	2 404.03
REVISION DATE: December, 2022	SHEET #: 1 of 1

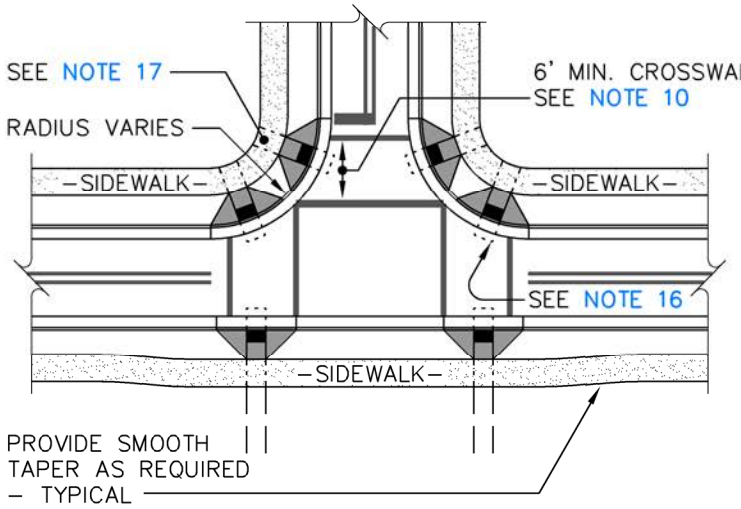
PROPOSED CURB RAMP

–SIDEWALK– PROPOSED OR FUTURE SIDEWALK

FOR PROPOSED CROSSING INTERSECTIONS

DETAIL SHOWING TYPICAL LOCATION OF DUAL CURB RAMPS, PEDESTRIAN CROSSWALKS AND STOP LINES FOR PROPOSED TEE INTERSECTIONS





FOR PROPOSED TEE INTERSECTIONS

DETAIL SHOWING TYPICAL LOCATION OF CURB RAMPS, PEDESTRIAN CROSSWALKS AND STOP LINES FOR PROPOSED TEE INTERSECTIONS

NOTES:

1. Refer to "Curb Ramp Notes:" Detail 405.16 for notes referenced above and for additional ramp notes.
2. All striping shall be thermoplastic.
3. Ramps shall be installed for all legs of intersection.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD CURB RAMP PLACEMENT DETAIL

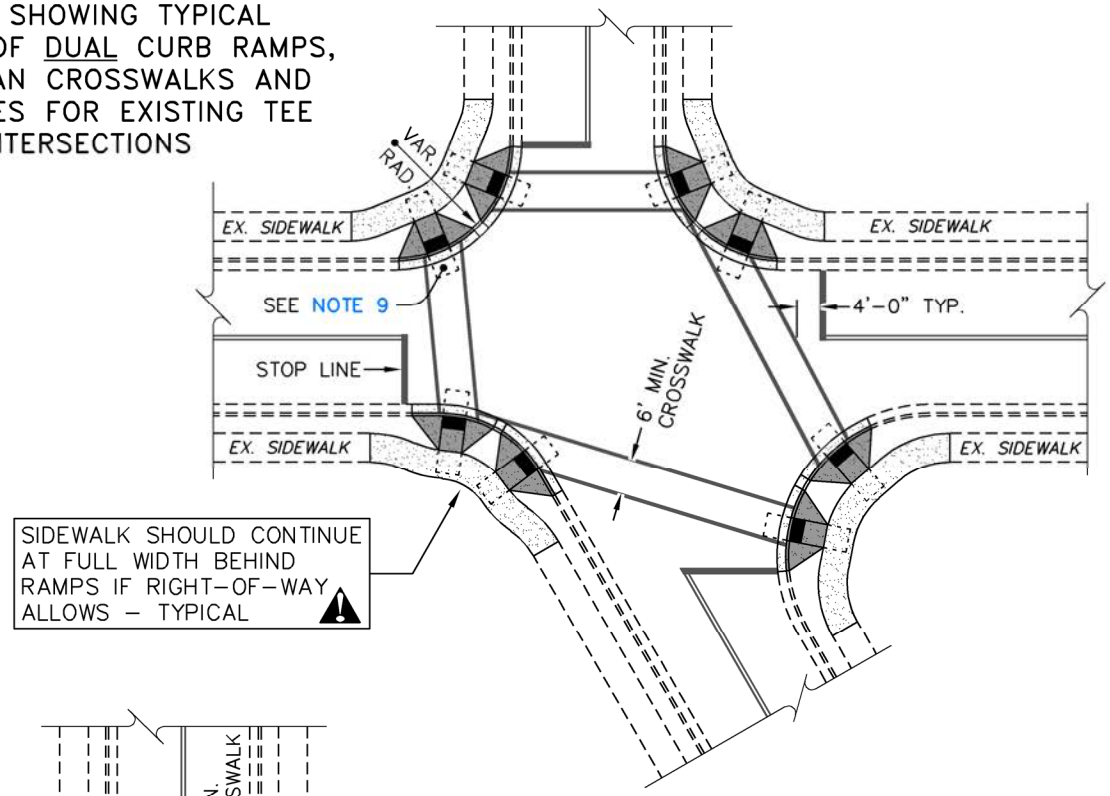
SCALE:	DETAIL #
Not To Scale	2 405.01
REVISION DATE: July, 2023	SHEET #: 1 of 2

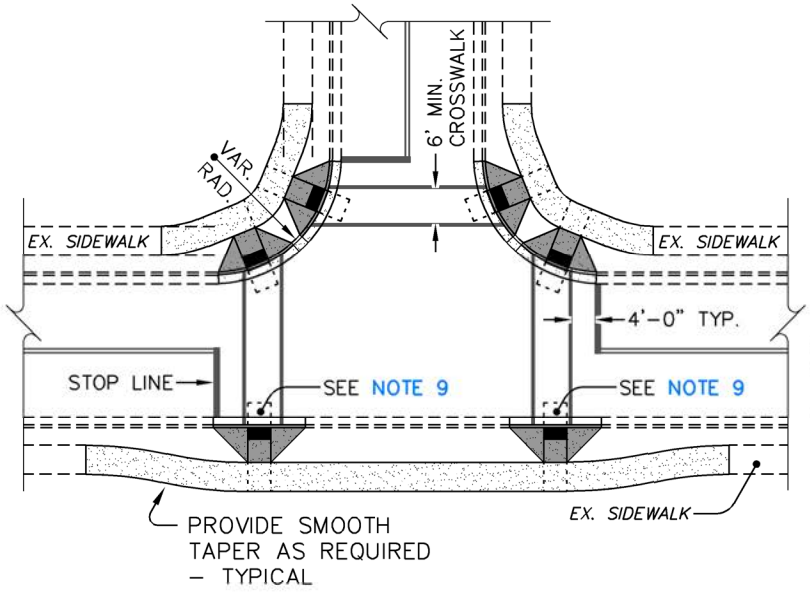
PROPOSED CURB RAMP

EX. SIDEWALK EXISTING SIDEWALK

FOR EXISTING CROSSING INTERSECTIONS

DETAIL SHOWING TYPICAL LOCATION OF DUAL CURB RAMPS, PEDESTRIAN CROSSWALKS AND STOP LINES FOR EXISTING TEE INTERSECTIONS





FOR EXISTING TEE INTERSECTIONS

DETAIL SHOWING TYPICAL LOCATION OF CURB RAMPS, PEDESTRIAN CROSSWALKS AND STOP LINES FOR EXISTING TEE INTERSECTIONS

NOTES:

1. Refer to "Curb Ramp Notes:" Detail 405.16 for notes referenced above and for additional ramp notes.
2. Adopted from NCDOT detail 848.05 & 848.06.

TOWN of CLAYTON

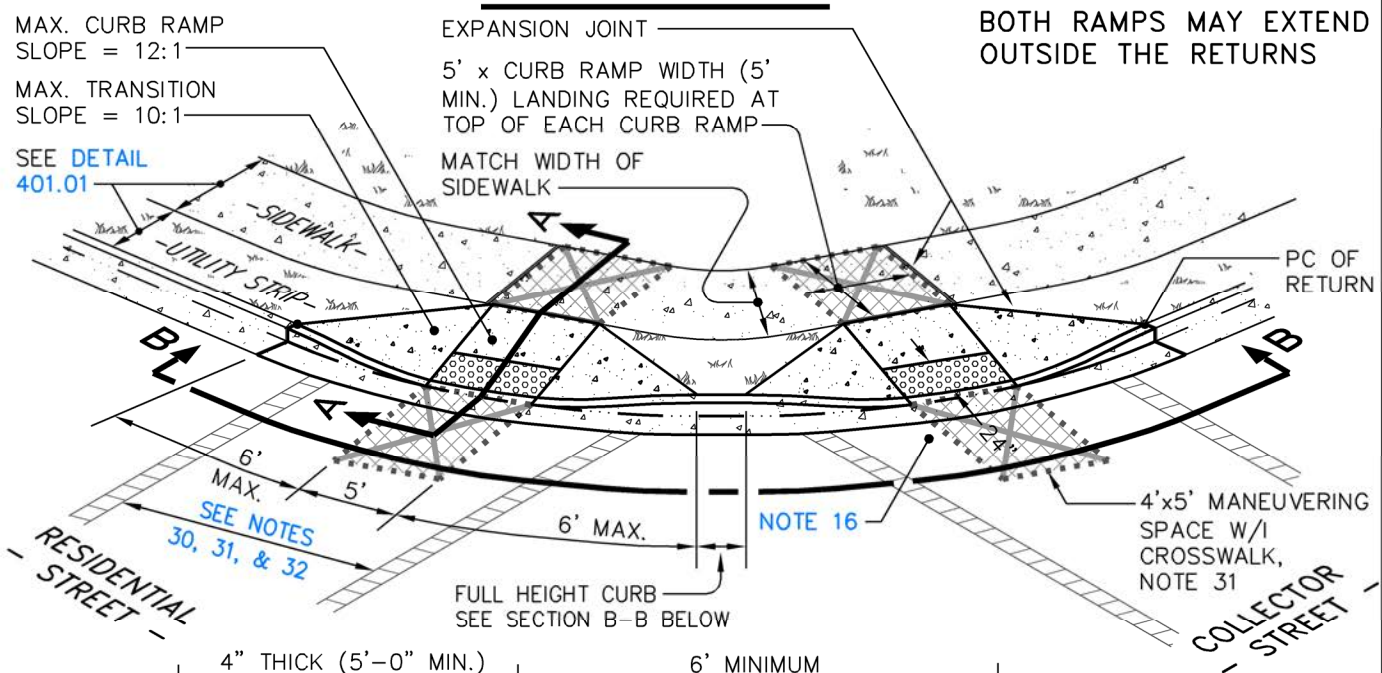
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

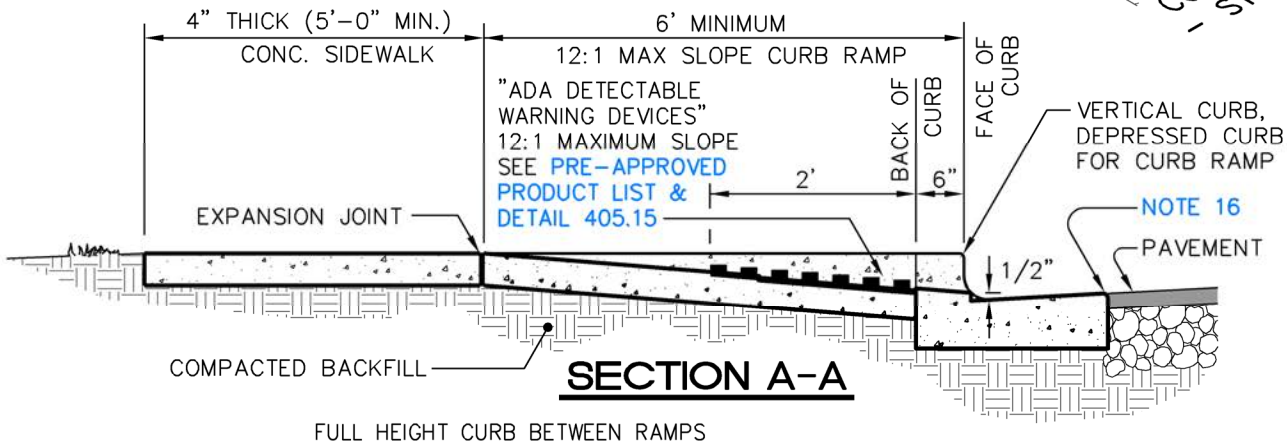
STANDARD CURB RAMP PLACEMENT DETAIL

SCALE:	DETAIL #
Not To Scale	405.01
REVISION DATE:	SHEET #:
July, 2023	2 of 2

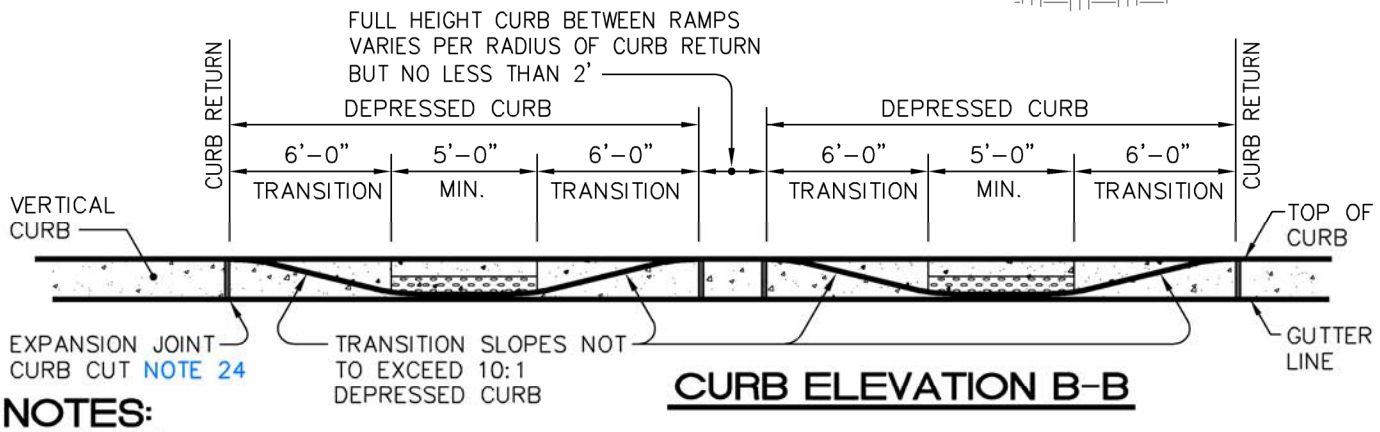
ISOMETRIC VIEW

NOTE: A PORTION OF ONE OR BOTH RAMPS MAY EXTEND OUTSIDE THE RETURNS





SECTION A-A



CURB ELEVATION B-B

NOTES:

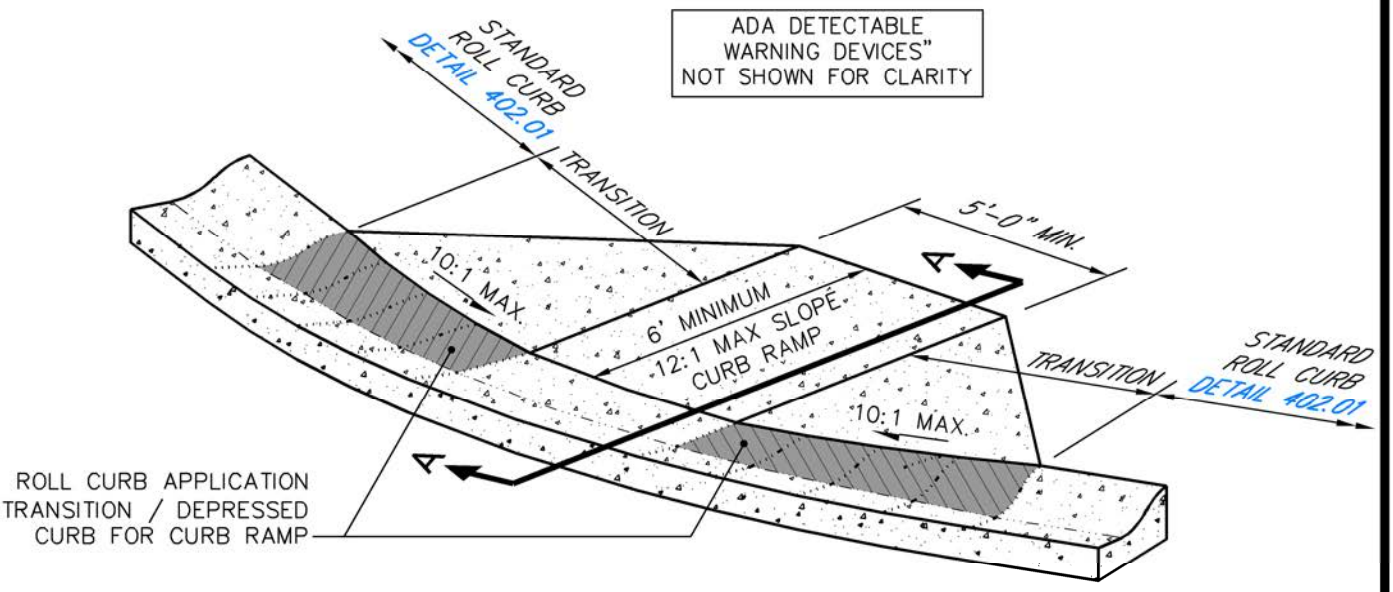
1. Detectable warning domes will cover 2'-0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Sheet 2 for Roll curb transition application.

TOWN of CLAYTON

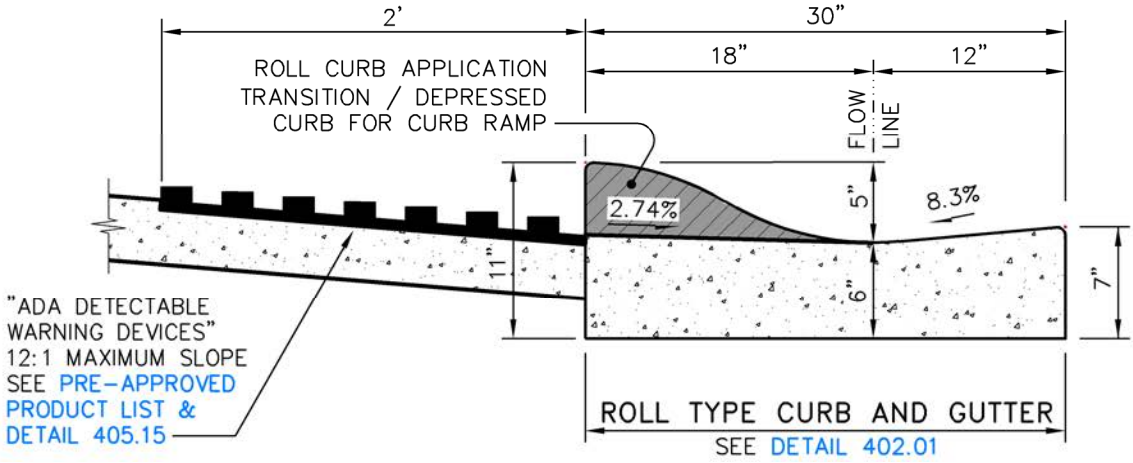
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL DOUBLE CURB RAMP

SCALE:	DETAIL #
Not To Scale	405.02
REVISION DATE: July, 2023	SHEET #: 1 of 2



PERSPECTIVE VIEW



SECTION A-A

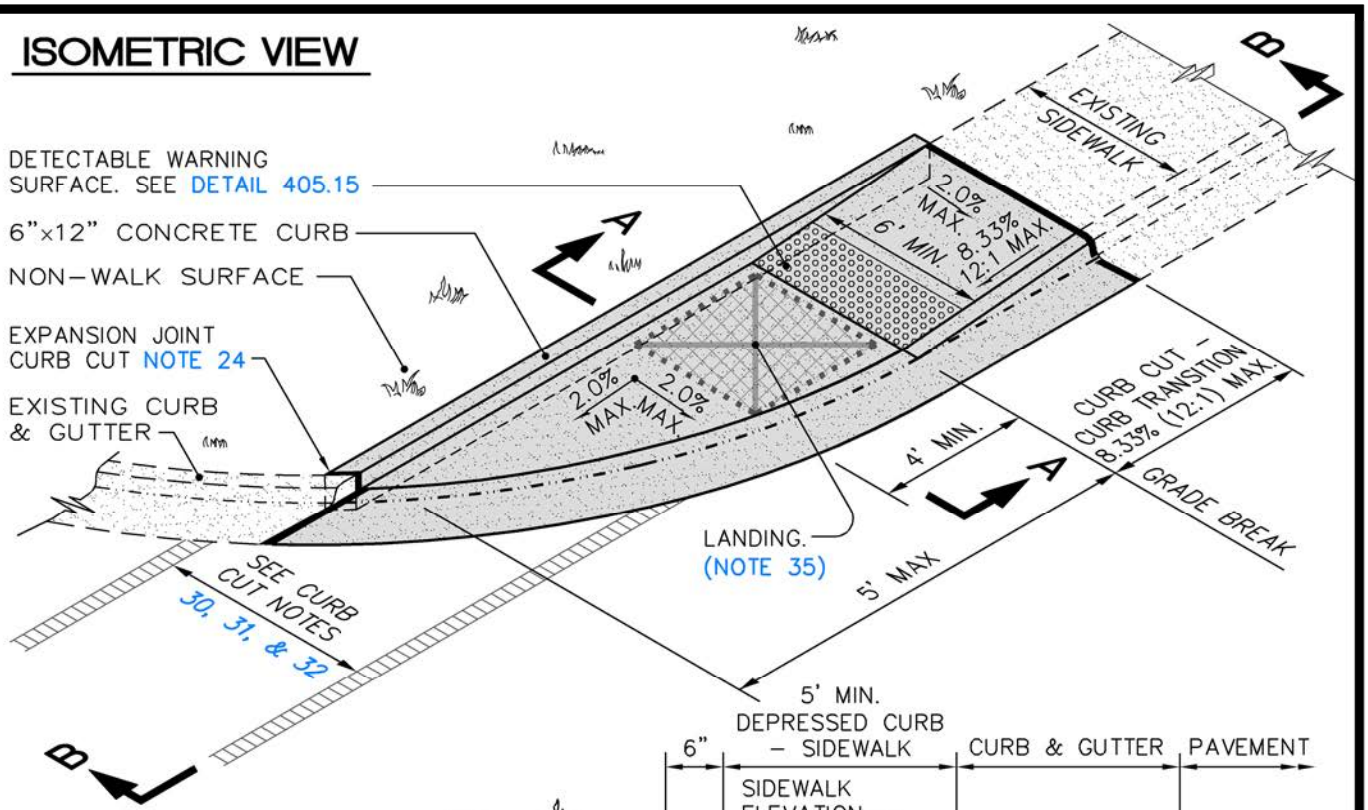
TOWN of CLAYTON

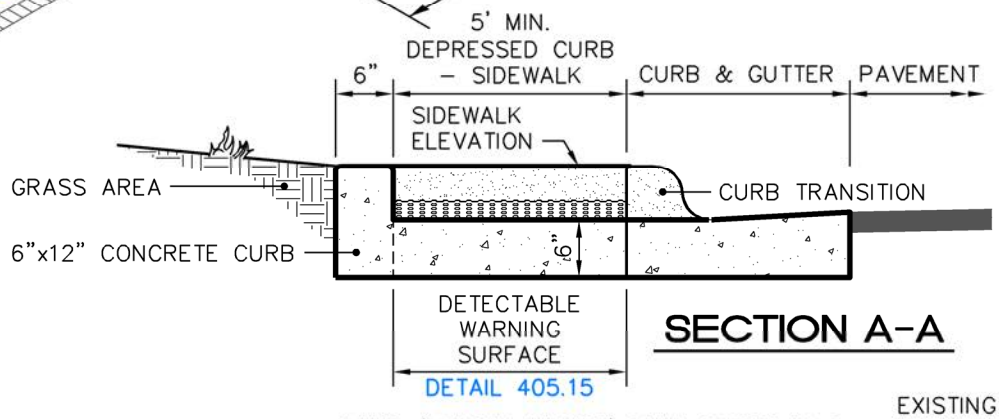
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

ROLL CURB TRANSITION ALONG CURB RAMPS

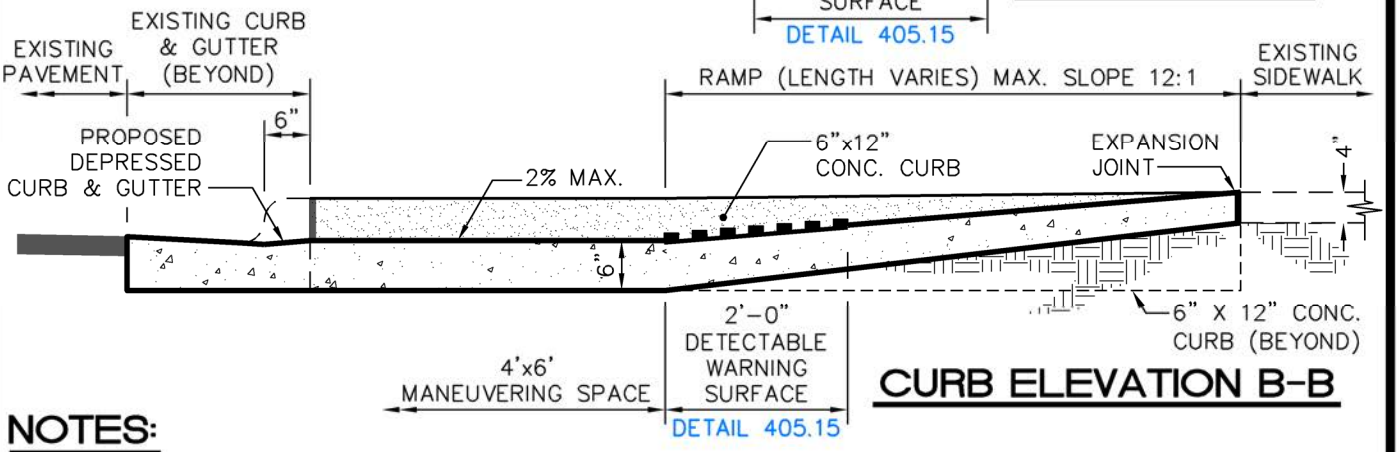
SCALE:	DETAIL #
Not To Scale	405.02
REVISION DATE:	SHEET #:
July, 2023	2 of 2

ISOMETRIC VIEW





SECTION A-A



CURB ELEVATION B-B

NOTES:

1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. This detail for use at driveways and greenways only. Refer to detail 405.02 for street intersections.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

TOWN of CLAYTON

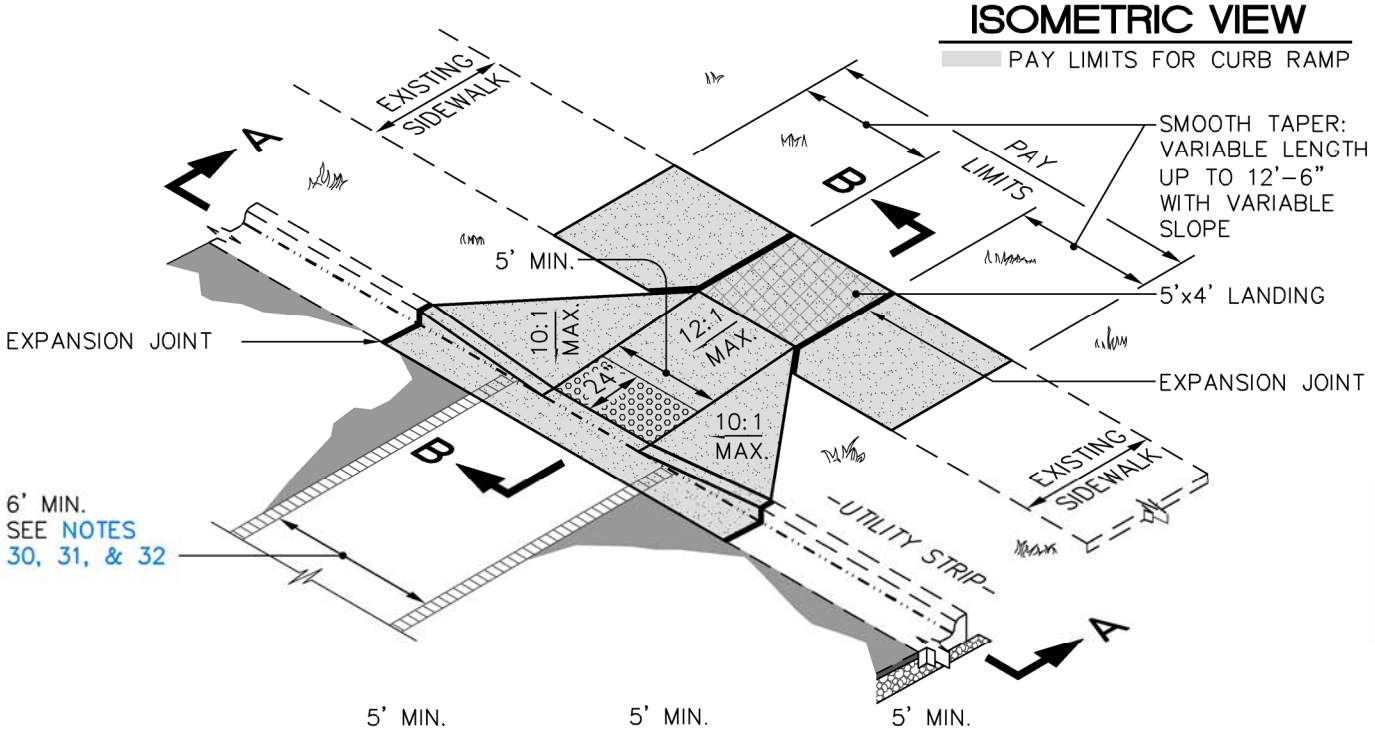
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

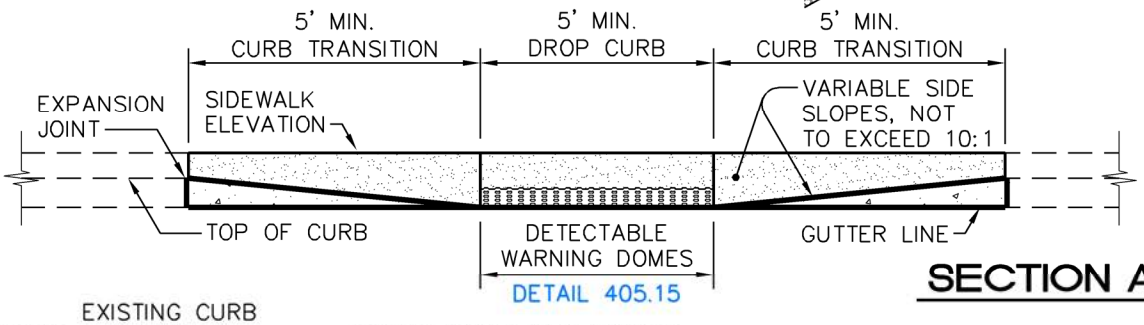
DIRECTIONAL CURB RAMPS TYPE 1

SCALE:	DETAIL #
Not To Scale	405.03
REVISION DATE:	SHEET #:
July, 2023	1 of 1

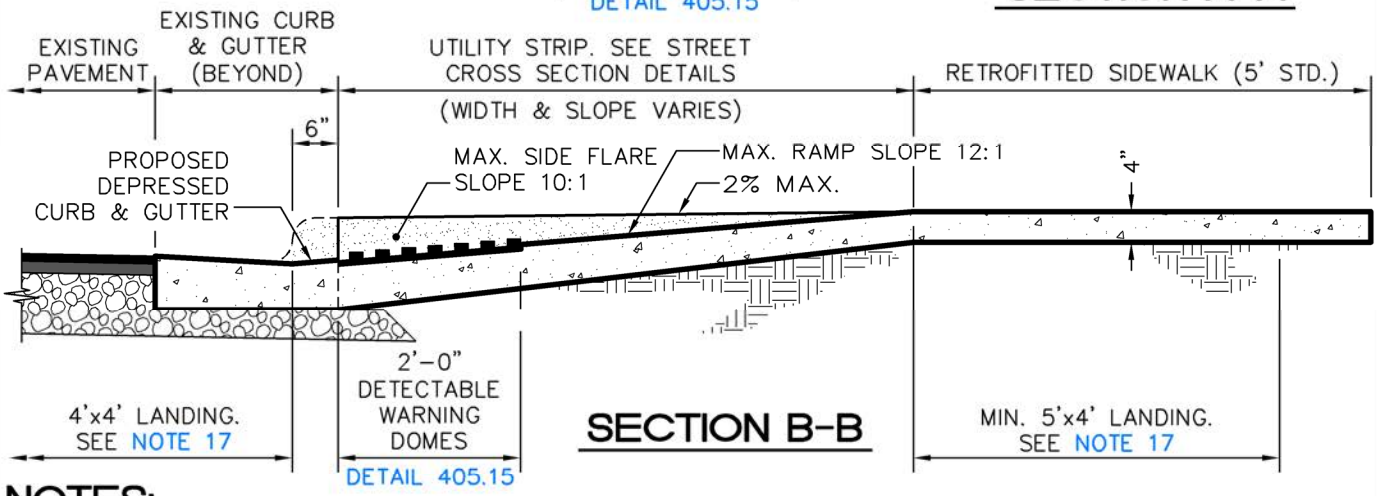
ISOMETRIC VIEW

PAY LIMITS FOR CURB RAMP





SECTION A-A



SECTION B-B

NOTES:

1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

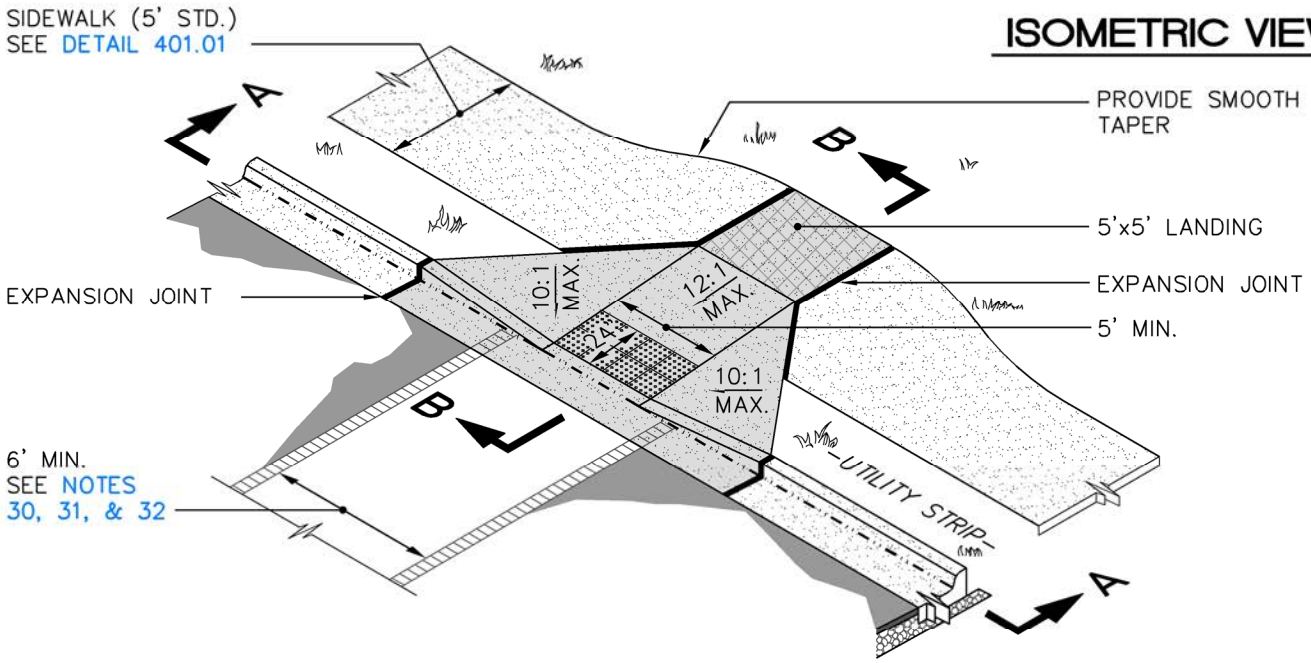
TOWN of CLAYTON

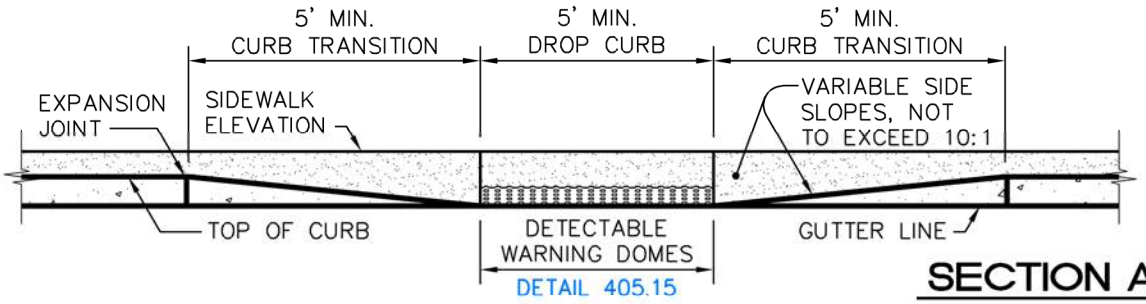
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SINGLE CURB RAMP WITH EXISTING CURB & GUTTER - TYPE 2

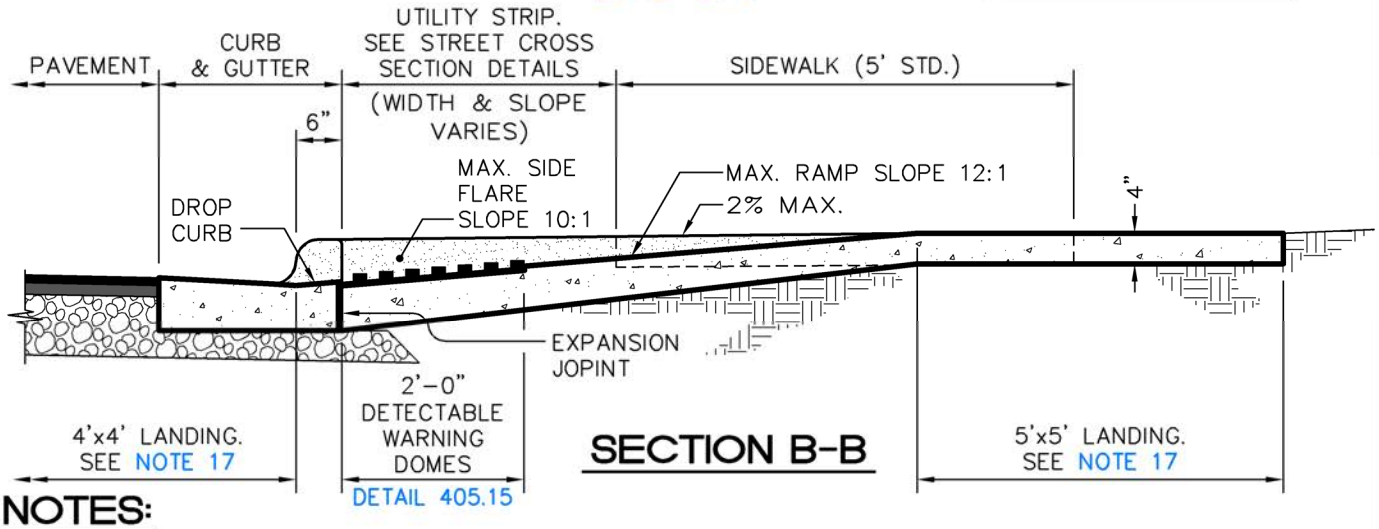
SCALE:	DETAIL #
Not To Scale	405.04
REVISION DATE:	SHEET #:
July, 2023	1 of 1

ISOMETRIC VIEW





SECTION A-A



SECTION B-B

NOTES:

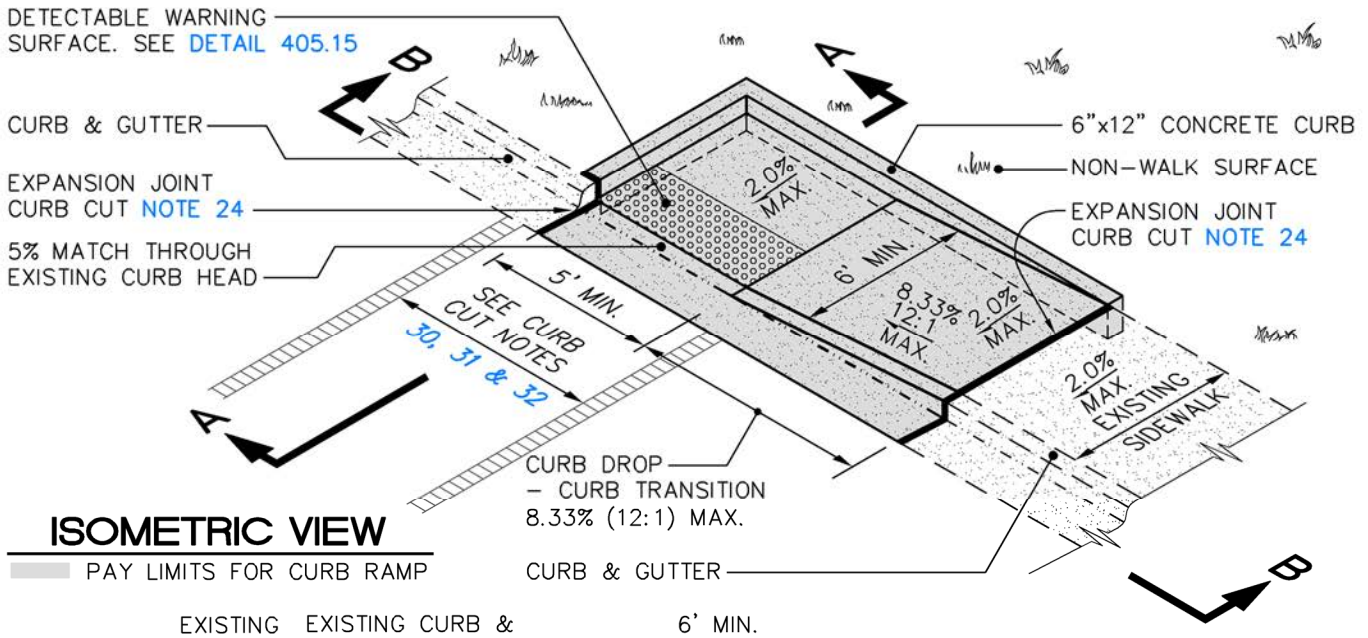
1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

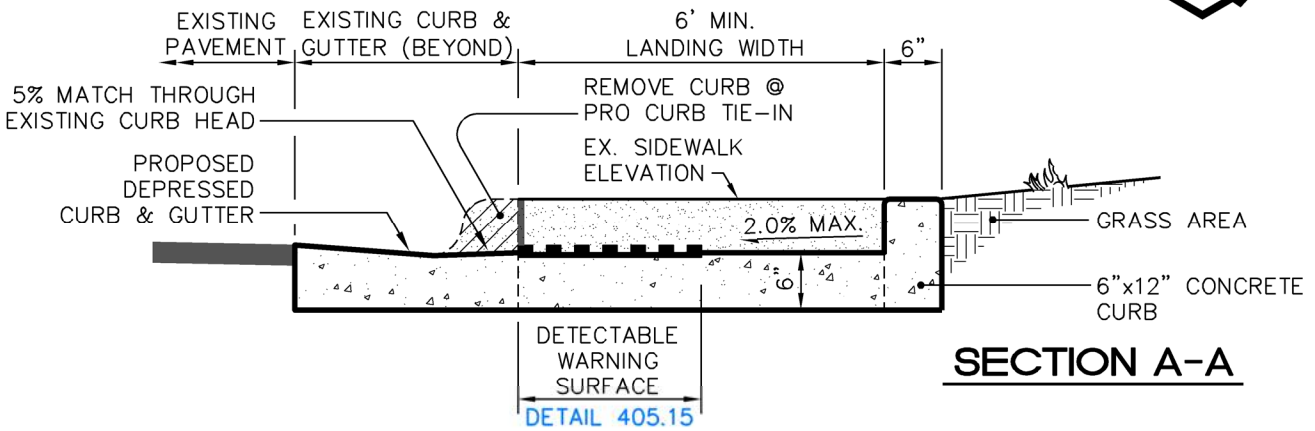
SINGLE CURB RAMP WITH PROPOSED CURB & GUTTER - TYPE 2A

SCALE:	DETAIL #
Not To Scale	405.05
REVISION DATE: July, 2023	SHEET #: 1 of 1

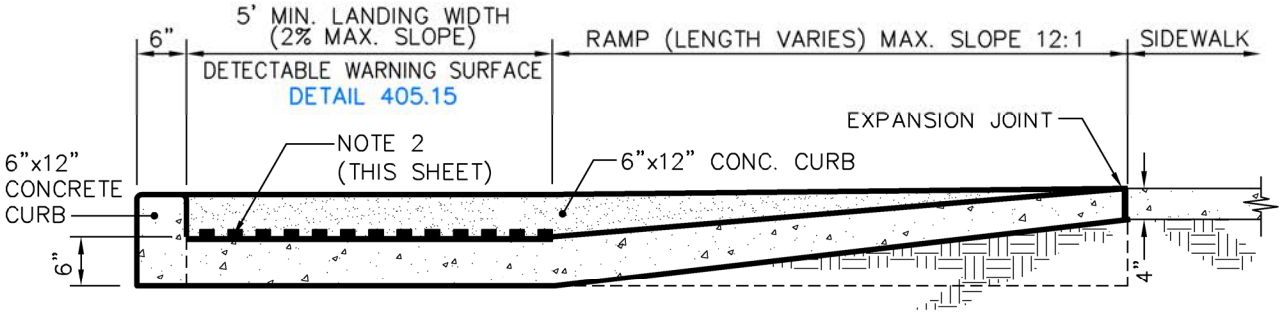


ISOMETRIC VIEW

PAY LIMITS FOR CURB RAMP



SECTION A-A



CURB ELEVATION B-B

NOTES:

1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

TOWN of CLAYTON

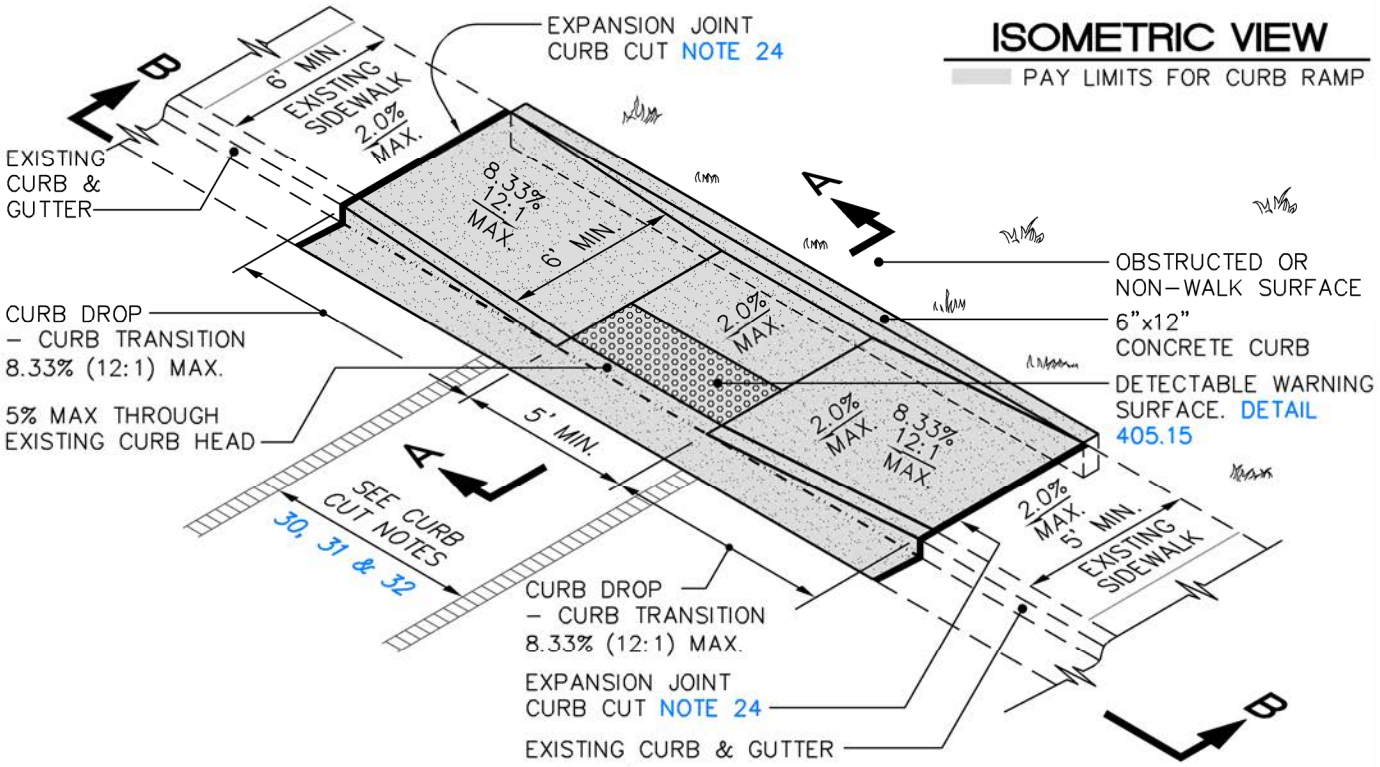
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

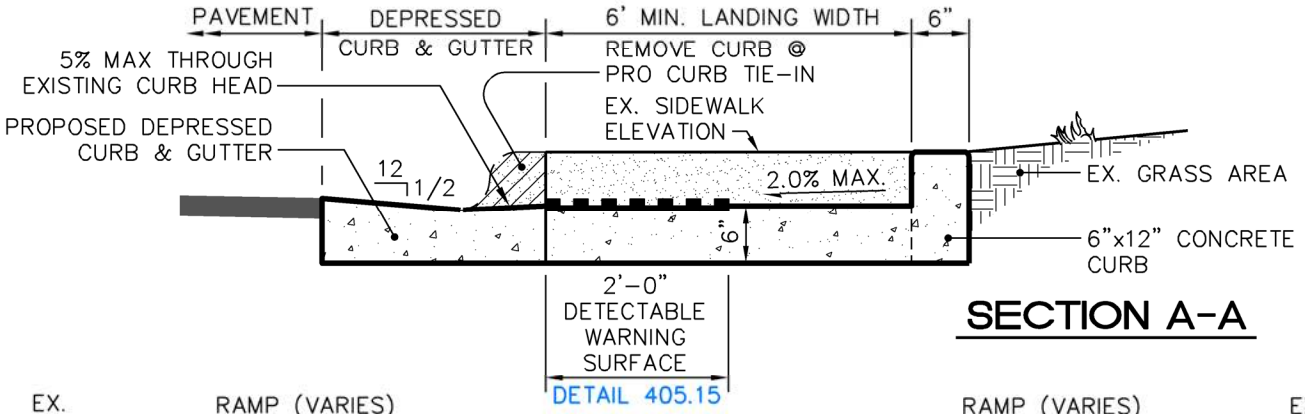
DIRECTIONAL CURB RAMPS TYPE 2B

SCALE:	DETAIL #
Not To Scale	405.06
REVISION DATE:	SHEET #:
July, 2023	1 of 1

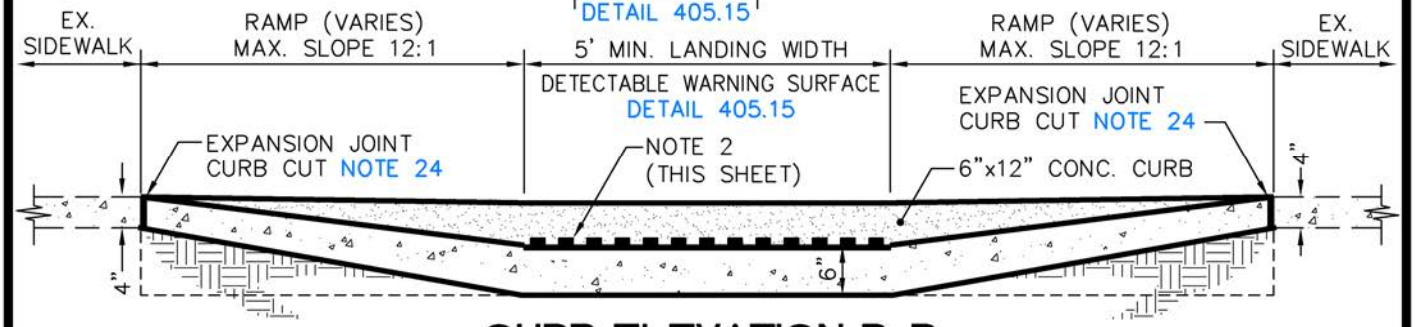
ISOMETRIC VIEW

PAY LIMITS FOR CURB RAMP





SECTION A-A



CURB ELEVATION B-B

NOTES:

1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

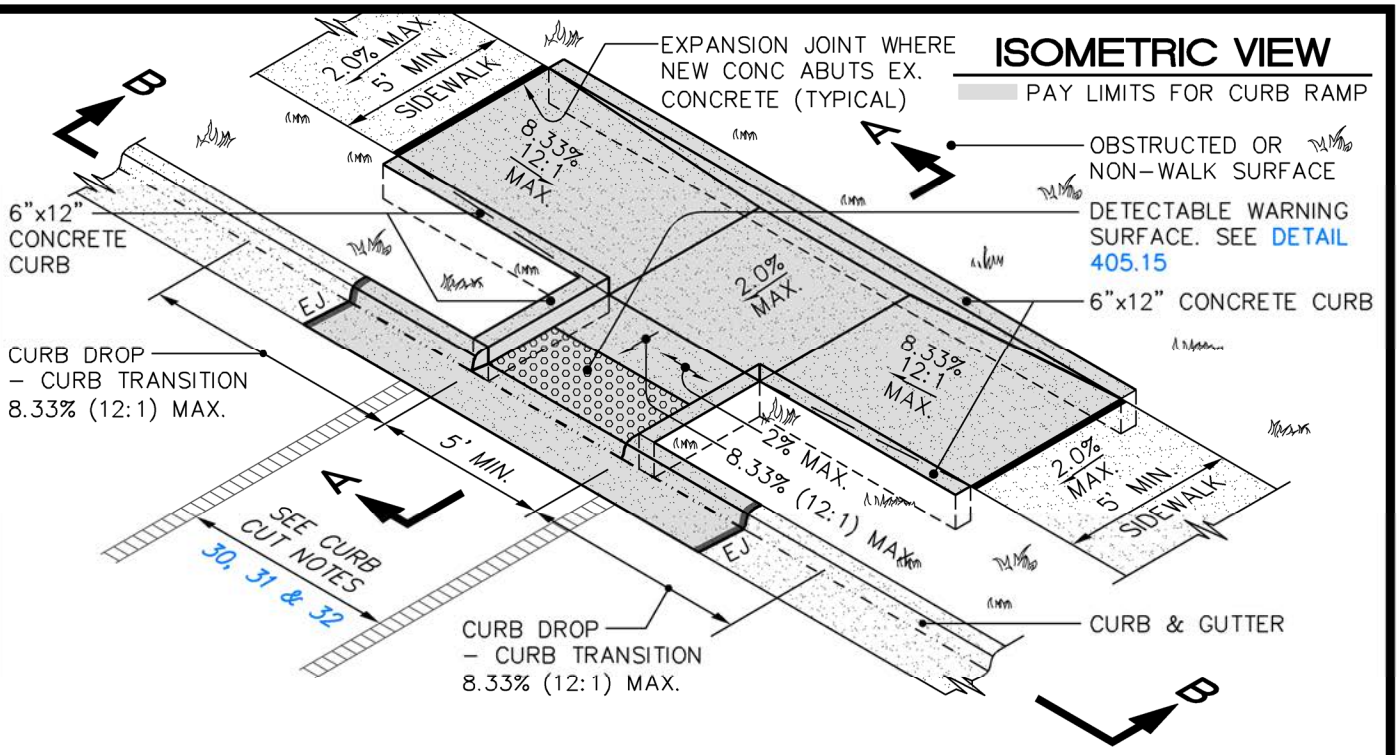
TOWN of CLAYTON

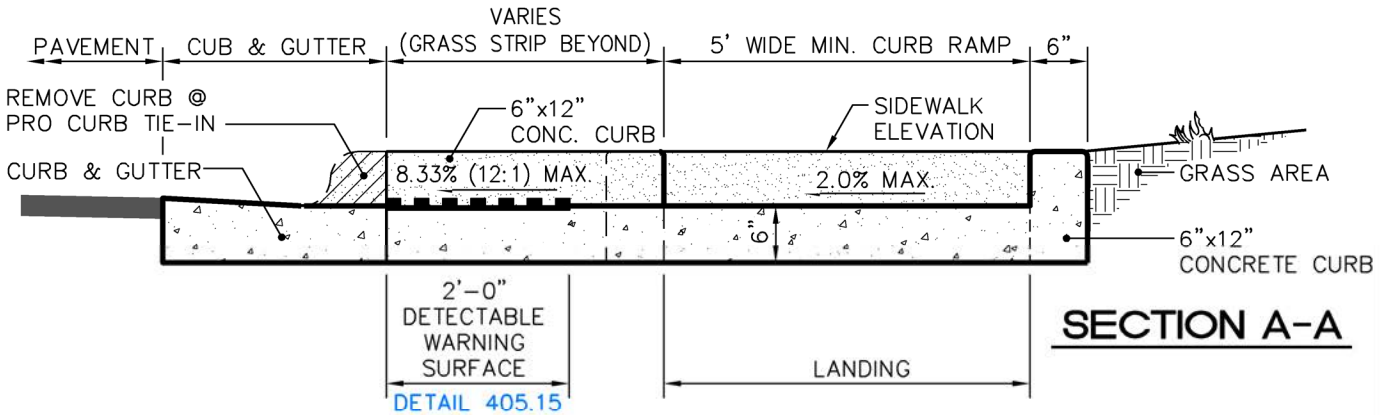
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PARALLEL CURB RAMPS TYPE 2C

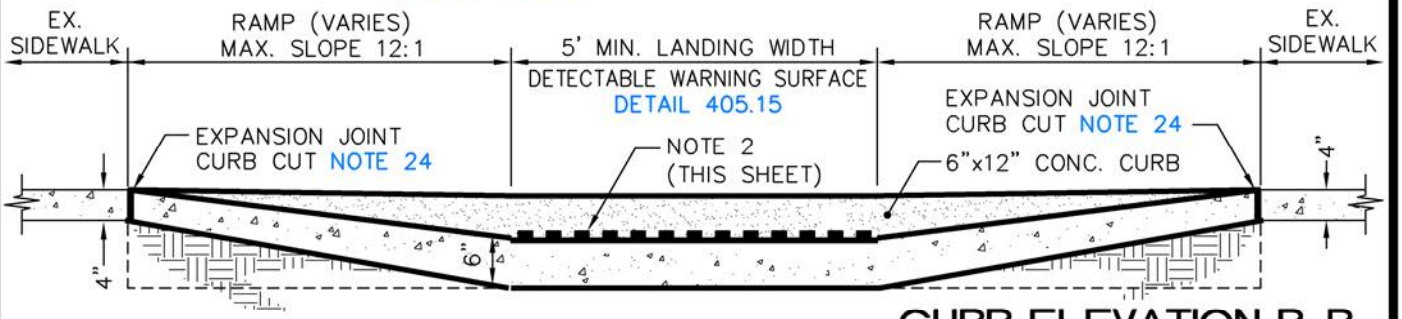
SCALE:	DETAIL #
Not To Scale	2 405.07
REVISION DATE: July, 2023	SHEET #: 1 of 1

ISOMETRIC VIEW





SECTION A-A



CURB ELEVATION B-B

NOTES:

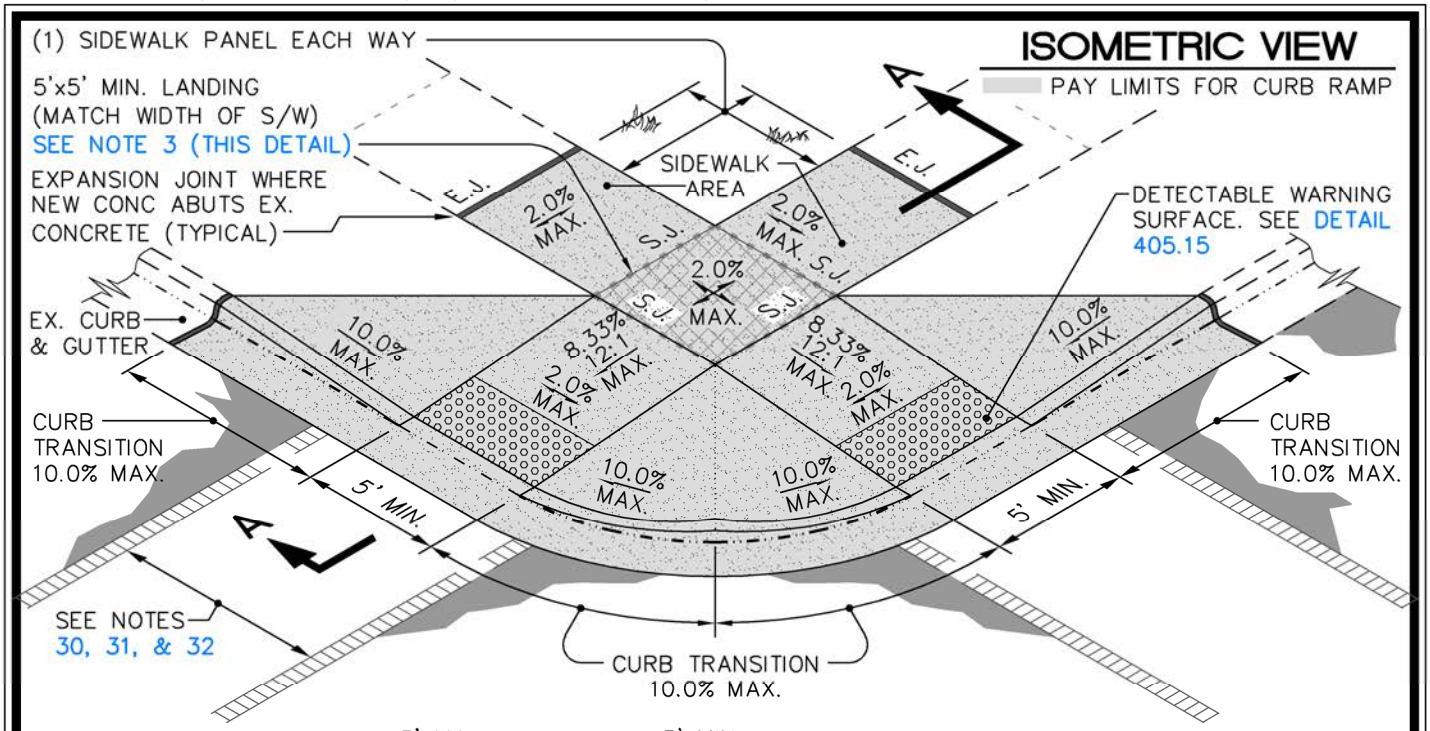
1. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
2. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
3. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

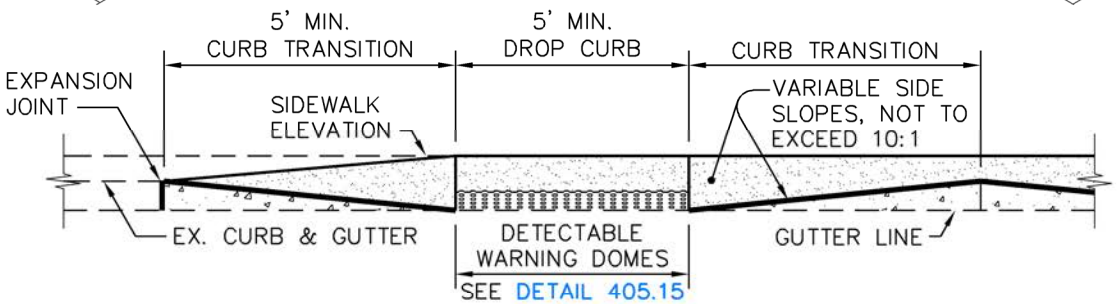
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

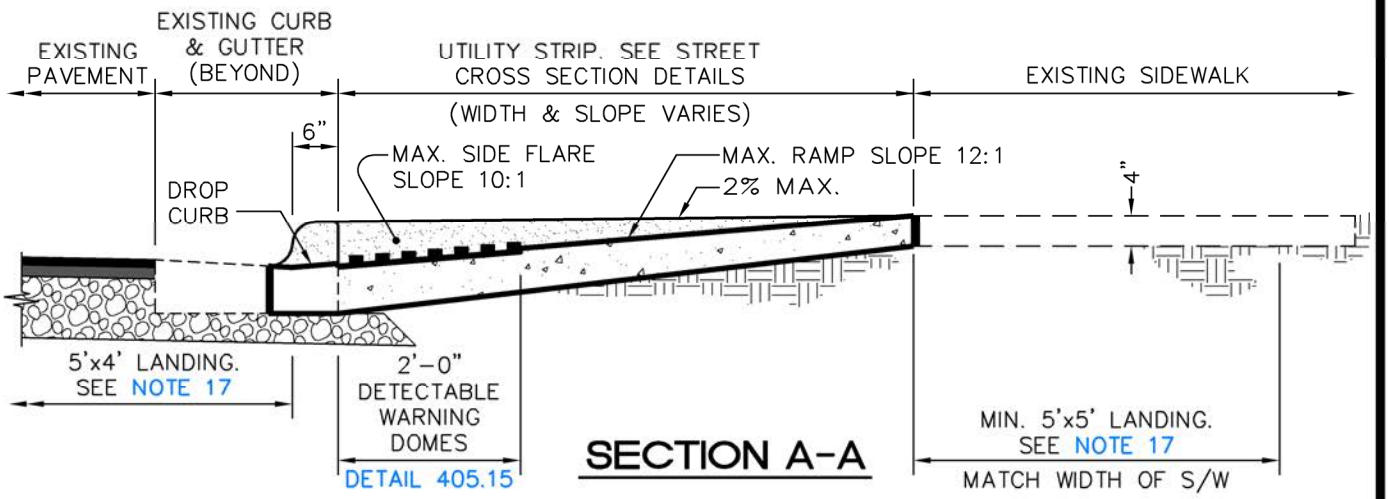
PARALLEL CURB RAMPS TYPE 2D

SCALE:	DETAIL #
Not To Scale	405.08
REVISION DATE: July, 2023	SHEET #: 1 of 1





PARTIAL CURB ELEVATION



SECTION A-A

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB RAMPS - SHARED LANDING TYPE 4

SCALE:	DETAIL #
Not To Scale	405.09
REVISION DATE:	SHEET #:
July, 2023	1 of 2

NOTES:

1. Maximum curb ramp slope 8.33% (12:1)
2. Maximum cross slope 2.00%
3. Curb ramps require a (5'–0") minimum landing with a maximum cross slope and longitudinal slope of 2.00% where pedestrians perform turning maneuvers. Slope to drain to curb.
4. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on Detail 405.15.
5. Refer to Detail 405.16 for all ramp notes. Adopted from NCDOT Alternate Curb Ramp Details.
6. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

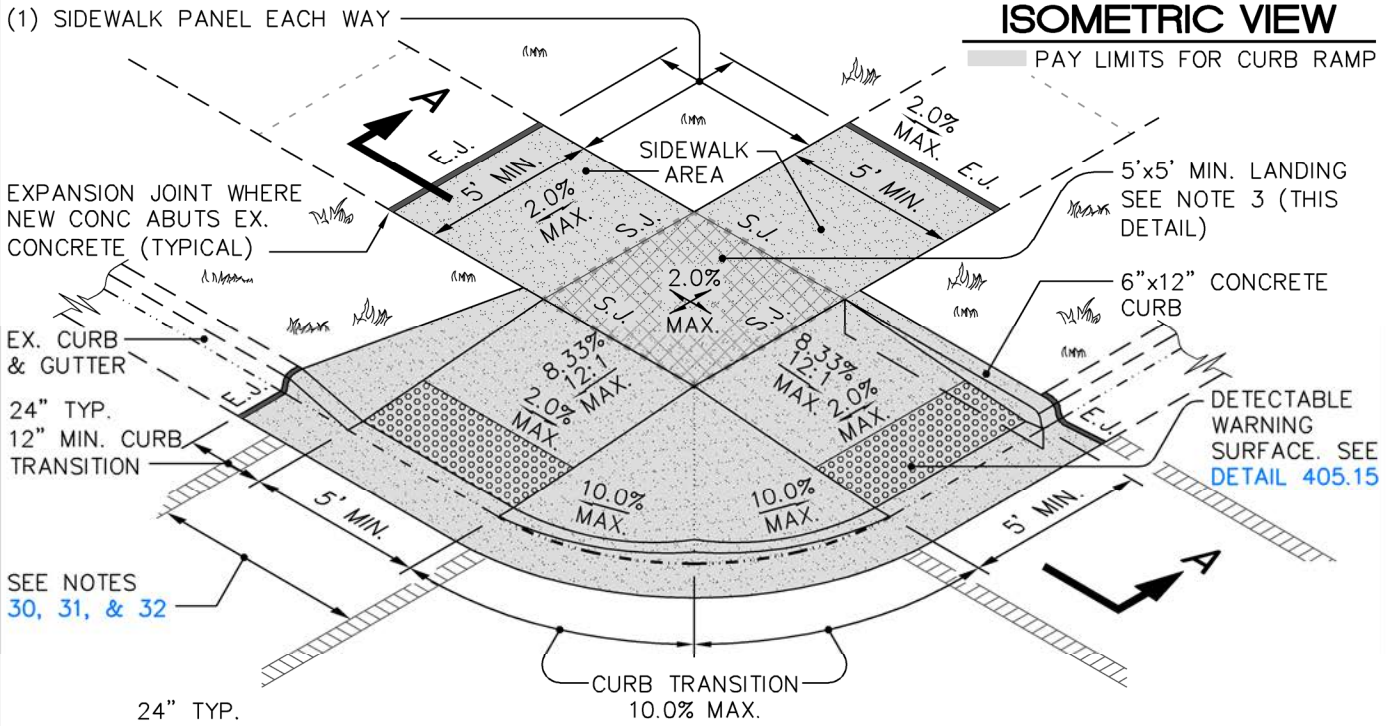
TOWN of CLAYTON

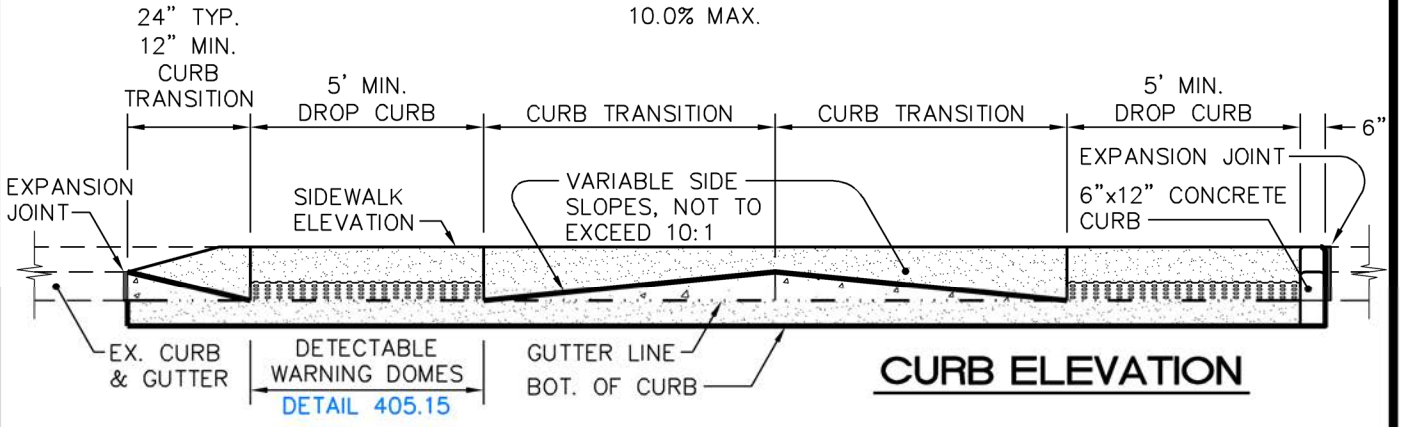
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB RAMPS-SHARED LANDING TYPE 4

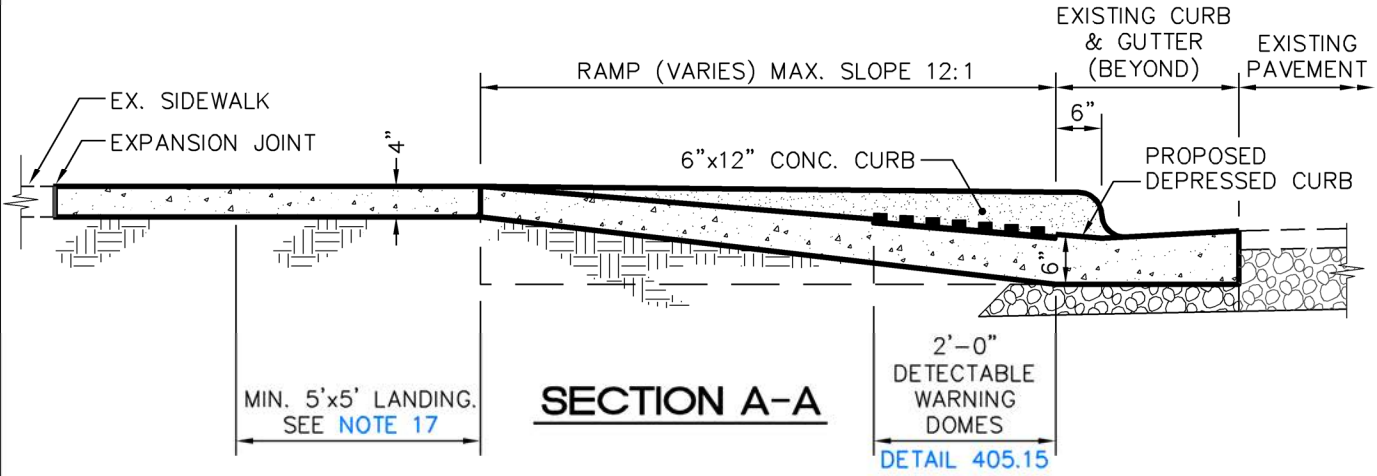
SCALE:	DETAIL #
Not To Scale	2 405.09
REVISION DATE: July, 2023	SHEET #: 2 of 2

ISOMETRIC VIEW





CURB ELEVATION



SECTION A-A

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB RAMPS - SHARED LANDING TYPE 4B

SCALE:	DETAIL #
Not To Scale	405.10
REVISION DATE:	SHEET #:
July, 2023	1 of 2

NOTES:

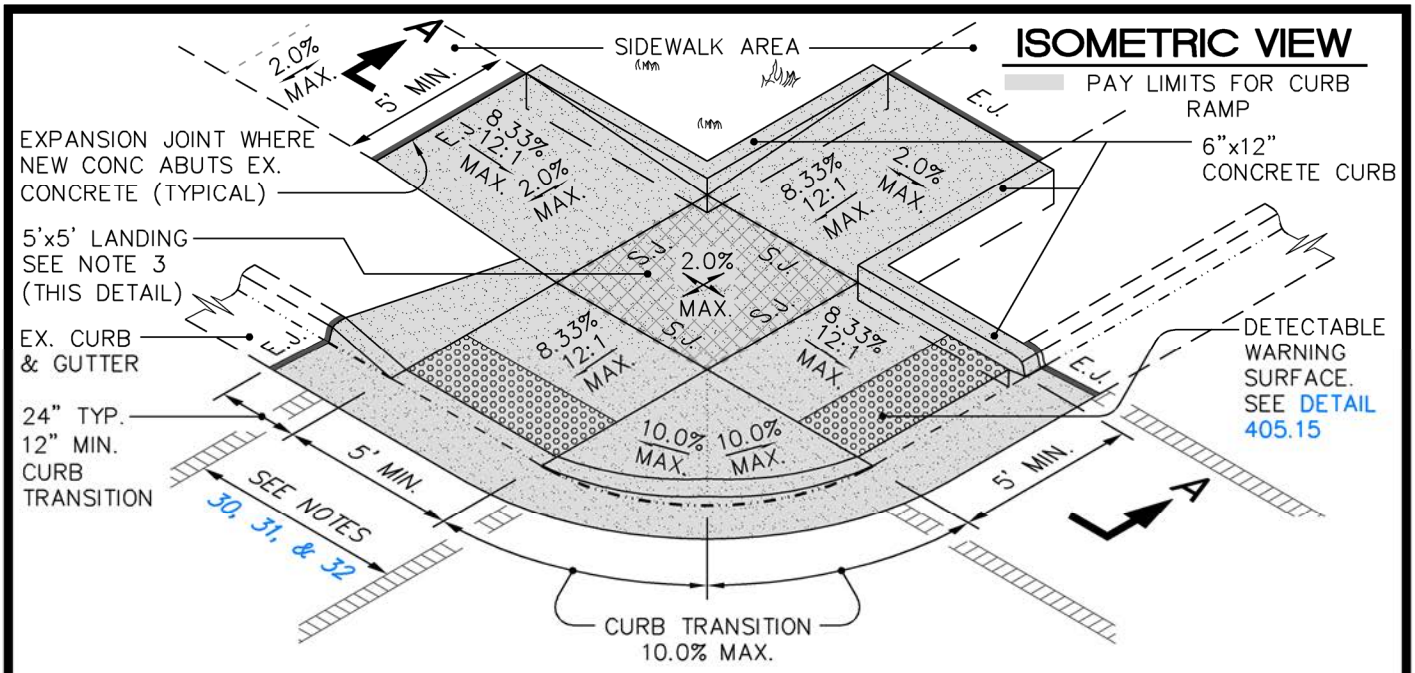
1. Maximum curb ramp slope 8.33% (12:1)
2. Maximum cross slope 2.00%
3. Curb ramps require a (5'–0") minimum landing with a maximum cross slope and longitudinal slope of 2.00% where pedestrians perform turning maneuvers. Slope to drain to curb.
4. Detectable warning domes will cover 2'–0" length and full width of the ramp floor as shown on detail 405.15.
5. Refer to detail 405.16 for all ramp notes. Adopted from NCDOT Alternate Curb Ramp Details.
6. Refer to Detail 405.02 (Sheet 2 of 2) for Roll curb transition application.

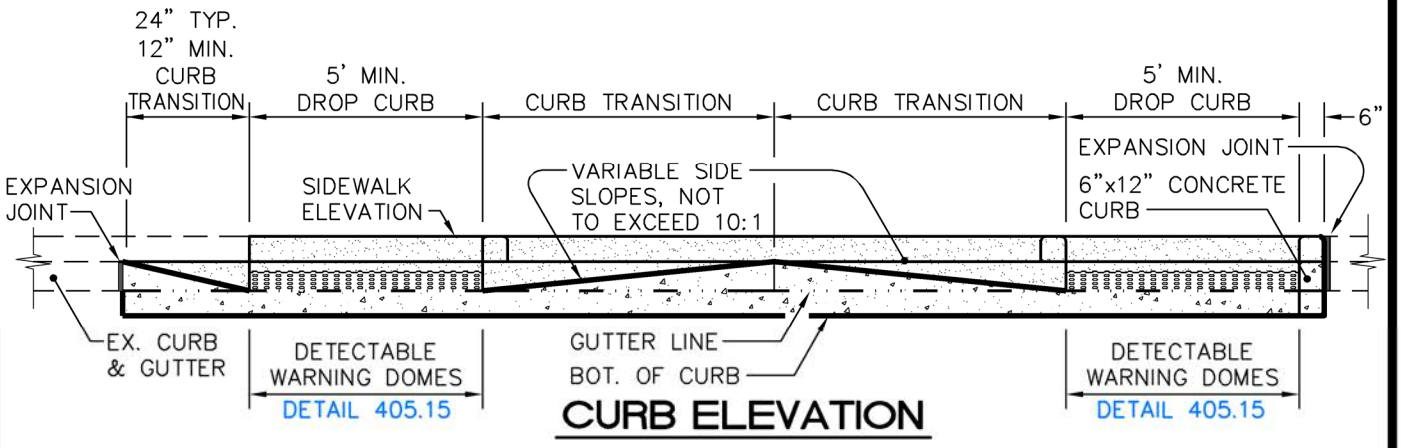
TOWN of CLAYTON

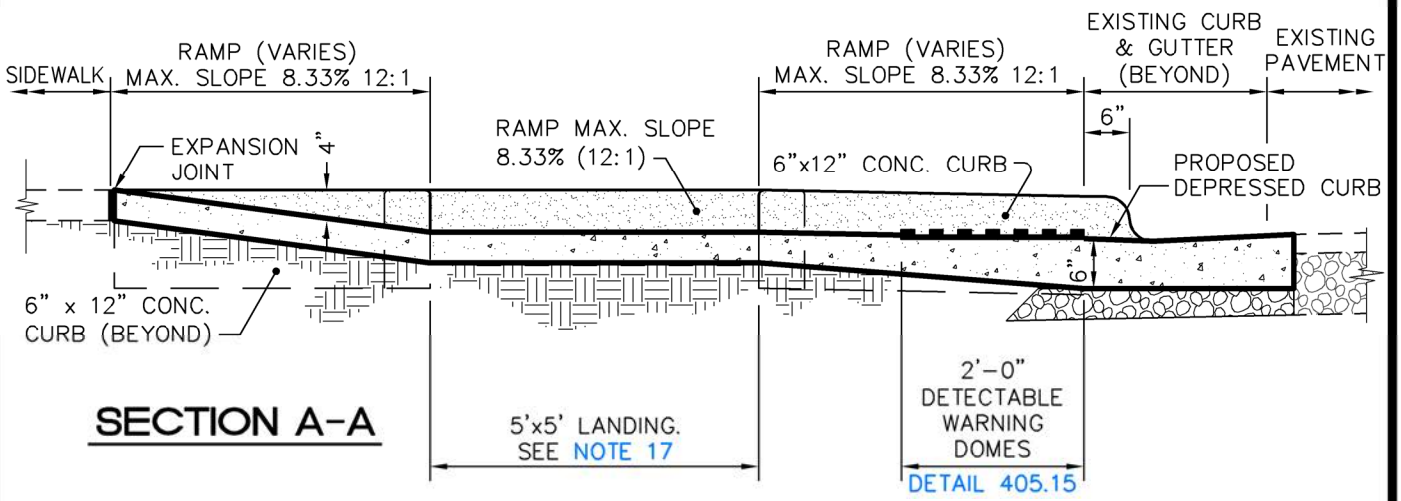
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB RAMPS - SHARED LANDING TYPE 4B

SCALE:	DETAIL #
Not To Scale	2 405.10
REVISION DATE: July, 2023	SHEET #: 2 of 2







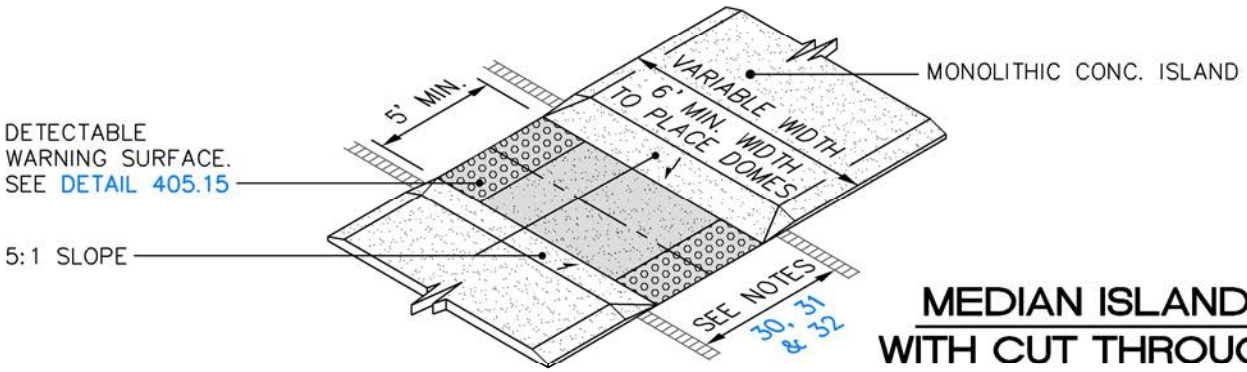
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

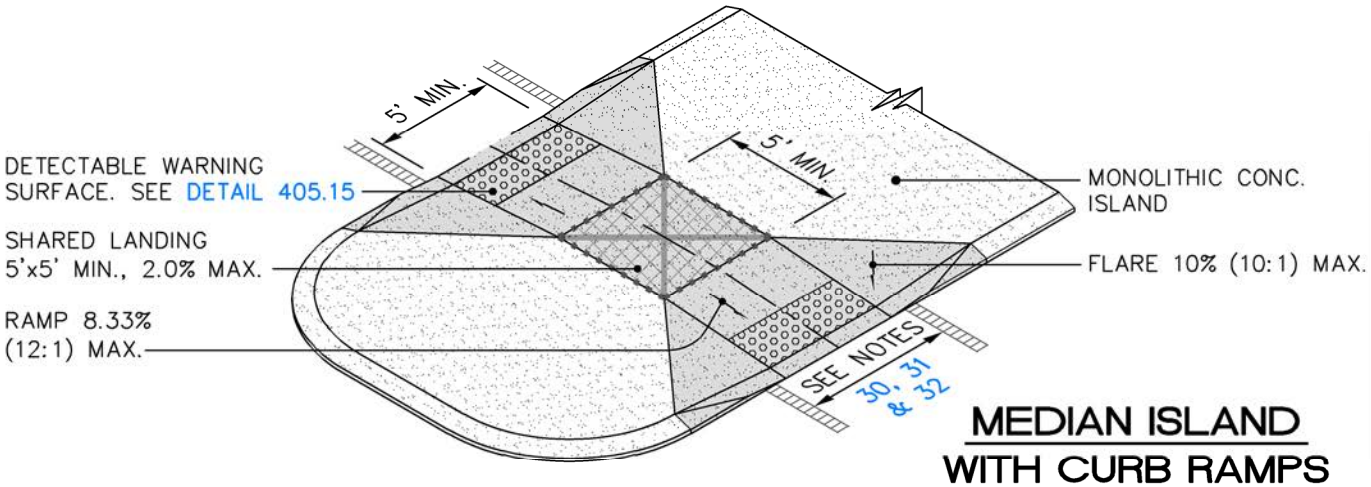
CURB RAMPS - SHARED LANDING TYPE 4C

SCALE:	DETAIL #
Not To Scale	2 405.11
REVISION DATE: July, 2023	SHEET #: 1 of 2

LIMITS FOR CURB RAMP



MEDIAN ISLAND WITH CUT THROUGH



MEDIAN ISLAND WITH CURB RAMPS

NOTES:

1. Refer to "Curb Ramp Notes:" Detail 405.16 for additional ramp notes.
2. Refer to Detail 405.15 for detectable warning surfaces.
3. See NCDOT Roadway Std. Drawing 852.01 for concrete island dimensions as applicable.
4. Adopted from NCDOT Curb Ramp Details Type 6, 7, and 8 Island ramps.

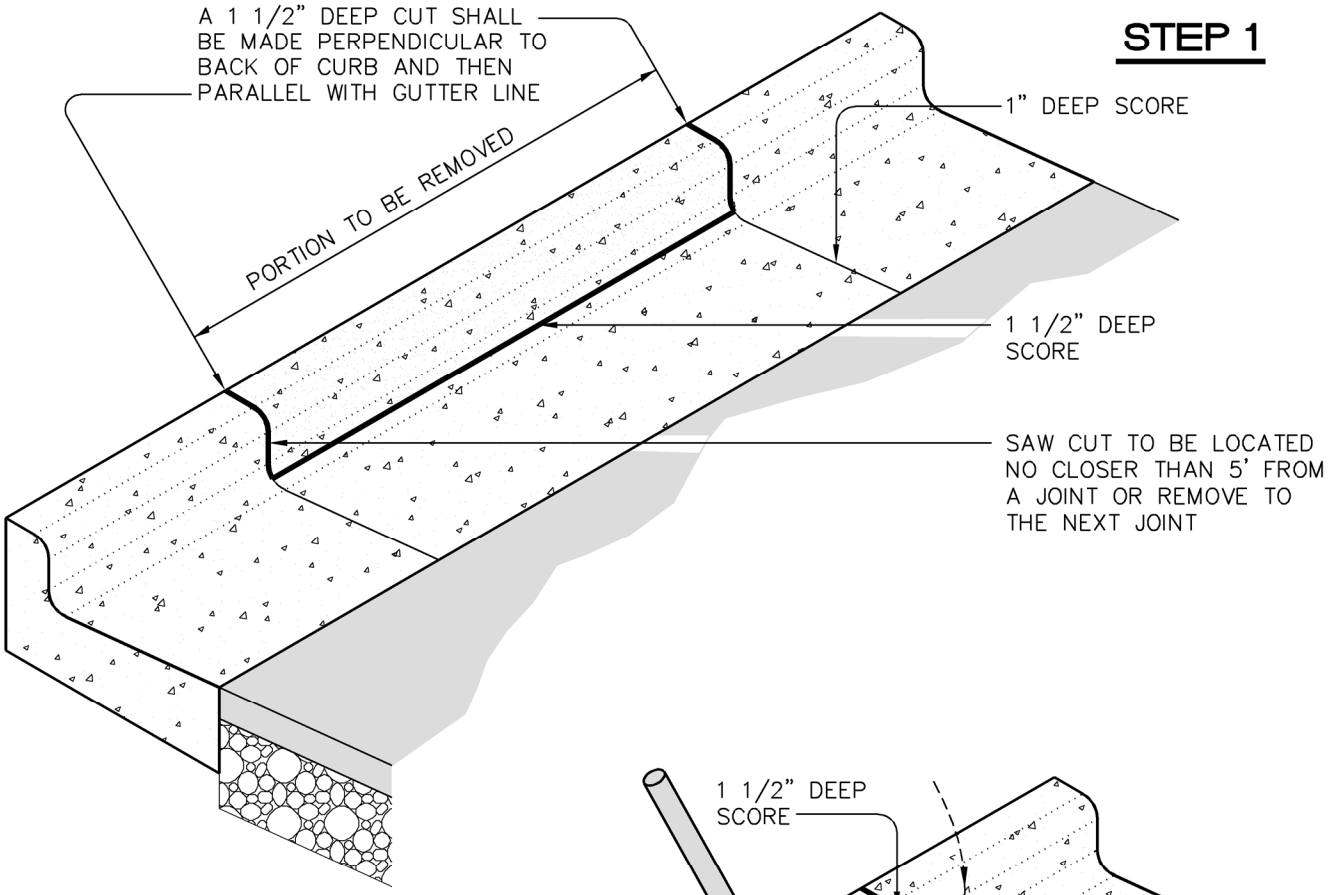
TOWN of CLAYTON

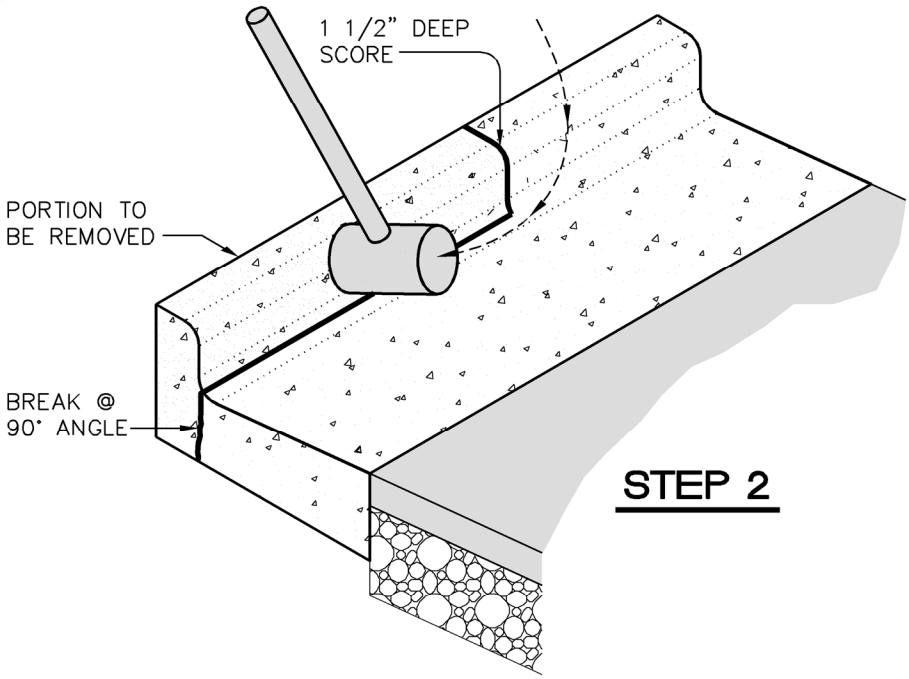
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB RAMPS MEDIAN ISLANDS

SCALE:	DETAIL #
Not To Scale	2 405.12
REVISION DATE: December, 2022	SHEET #: 2 of 2

EXISTING CURB & GUTTER PROCEDURE



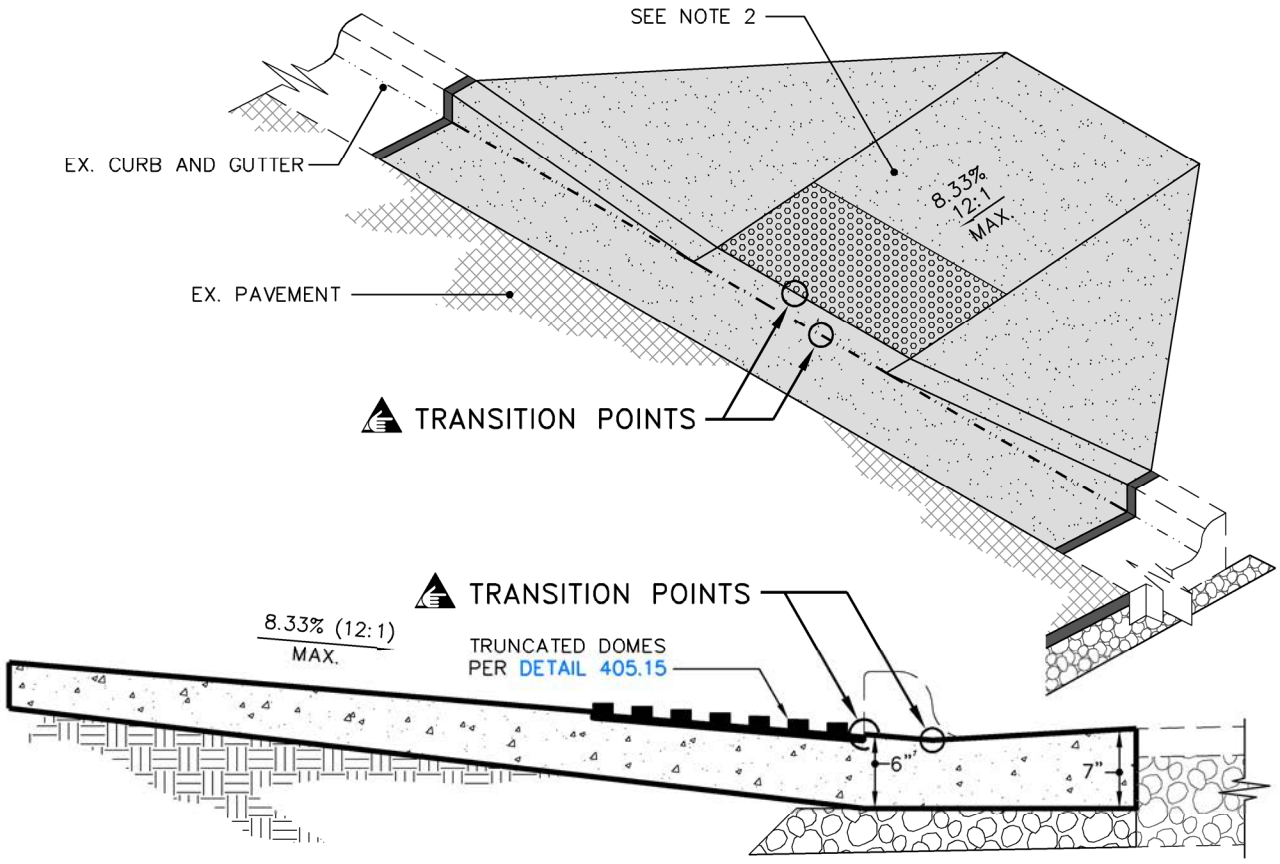


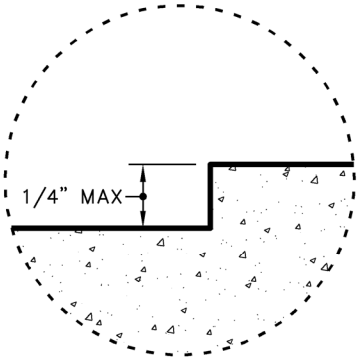
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

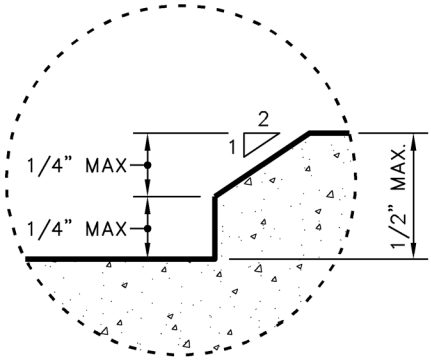
PROPOSED CURB CUT IN EXISTING CURB & GUTTER PROCEDURE

SCALE:	DETAIL #
Not To Scale	2405.13
REVISION DATE:	SHEET #:
Decmber, 2022	1 of 1





VERTICAL LIP



VERTICAL LIP WITH BEVEL

NOTES:

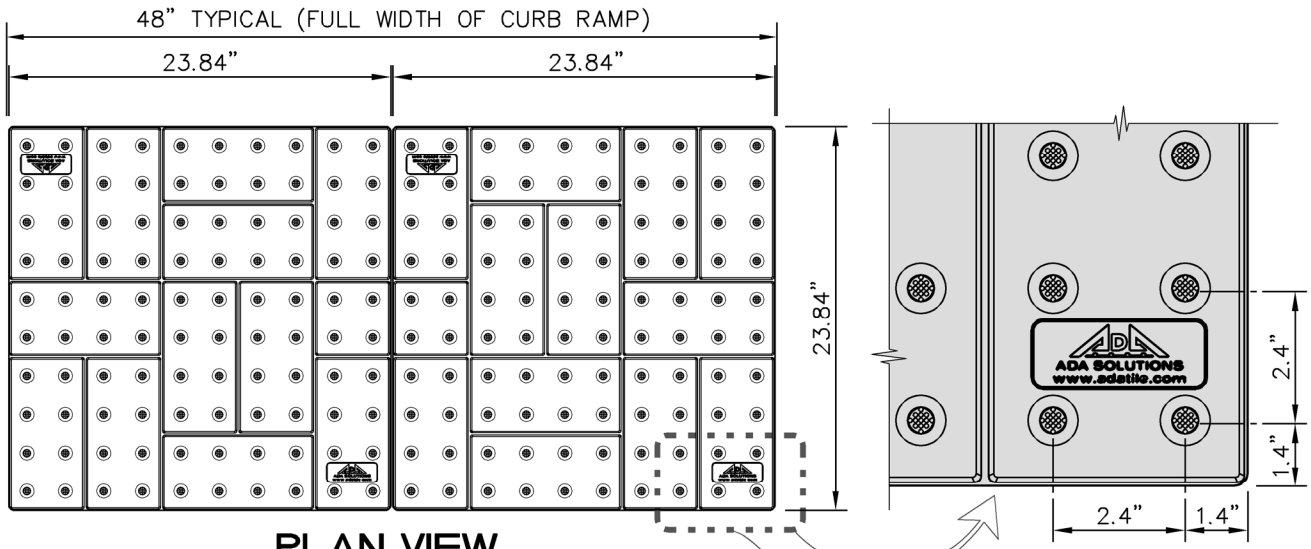
1. The transition between the truncated dome tray and the curb should be made to be flush. The transition between the curb and the gutter should be smooth or rounded. If neither a flush or smooth transition can be constructed, and the transitions change in level, up to ¼", then the lip may be vertical and without edge treatment. If the transitions change in level, between ¼" and ½", then the lip shall be beveled with a slope no greater than 1:2.
2. This detail is for transition points only, refer to curb cut details for proper curb layout / design. (Standard Details 405.02 thru 405.14)

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

CURB CUT RAMP TRANSITION POINTS

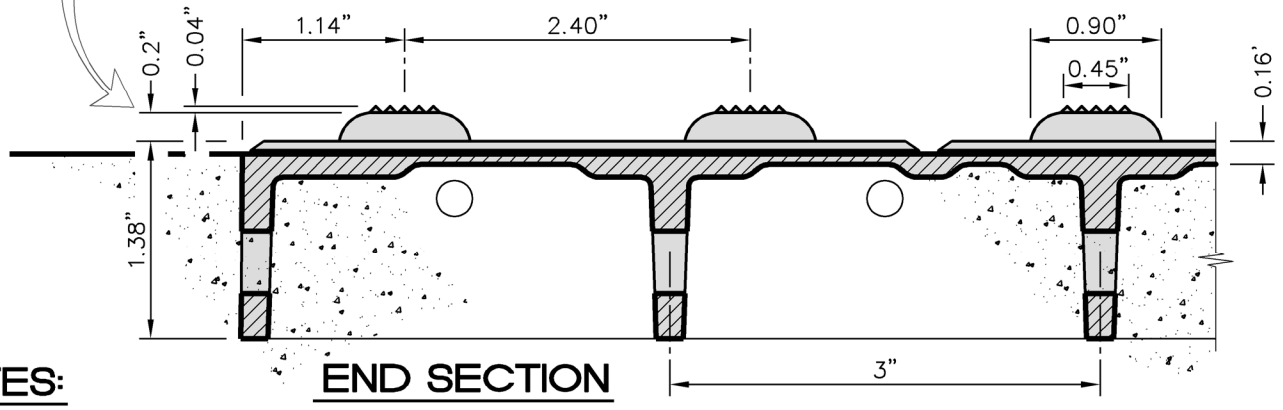
SCALE:	DETAIL #
Not To Scale	405.14
REVISION DATE: December, 2022	SHEET #: 1 of 1



PLAN VIEW



ELEVATION VIEW



END SECTION

NOTES:

1. Detectable warning System. See pre-approved products list.
2. Other sizes available to meet site specific requirements. Verify with Town.
3. Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inch minimum to 1.4 inches maximum, a top diameter of 50% of the base diameter minimum to 65% of the base diameter maximum, and a height of 0.2 inches.
4. Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches minimum and 2.4 inches maximum, and a base-to-base spacing of 0.65 inches minimum, measured between the most adjacent domes on square grid.
5. Detectable warning surfaces shall extend 24 inches minimum in the direction of travel and the full width of the curb ramp, landing, or blended transition. The edge nearest the curb line shall be a minimum of 6 inches and a maximum of 8 inches from curb (ICC/ANSI A117.1 Fig C406.13.2). See notes 21 & 22.
6. See note 23 on detail 405.16.
7. Any NCDOT street must conform to DOT standard/ADA Curb Ramp details 848.05 & 848.06 & NCDOT Alternate Curb Ramp Designs Section.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WHEELCHAIR RAMP DETECTABLE WARNING DOMES

SCALE:	DETAIL #
Not To Scale	405.15
REVISION DATE: December, 2022	SHEET #: 1 of 1

STANDARD NOTES:

1. North Carolina General Statute 136–44.14 requires that all street curbs being constructed or reconstructed for maintenance procedures, traffic operations, repairs, correction of utilities or altered for any reason after September 1, 1973 shall provide curb ramps for the physically disabled at all intersections where both curb and gutter and sidewalks are provided and at other points of pedestrian flow.
   In addition, section 228 of the 1973 Federal Aid Highway Safety Act requires provision of curb ramps on any curb construction after July 1, 1976 whether a sidewalk is proposed initially or is planned for a future date.
   The Americans with Disability Act (ADA) of 1990 extends to individuals with disabilities. Comprehensive civil rights protections similar to those provided to persons on the basis of race, sex, national origin and religion under the Civil Rights Act of 1964. These curb ramps have been designed to comply with the current ADA standards (2010 ADA Standards for Accessible Design, dated September 15, 2010 & effective March 15, 2012).
2. Curb ramps are required when streets are altered for resurfacing (spanning one intersection to another and includes overlay of additional material to the road surface with or without milling), reconstructed, rehabilitated or widened. Maintenance activities on streets, such as crack filling sealing, pavement markings, surface sealing and pavement patching, are not alterations. However, if there is no block–to–block resurfacing but resurfacing is occurring at a crosswalk itself, partial resurfacing (curb–to–curb resurfacing of a crosswalk) requires the provision of curb ramps at that crosswalk.
   Curb ramps are not required in the absence of a pedestrian walkway with a prepared surface nor are curb ramps required in the absence of curb, elevation or other barrier between the street and the walkway. [USDOJ July 8, 2013]
3. Curb ramps are required at all curb returns.
4. Detectable warning domes are required for all curb ramps.
5. Single curb ramp at the center of the return are not permitted.
6. Dimensions assume 90° centerline intersection of streets.
7. Construct the ramp surface to be stable, firm and slip resistant. Located and construct the curb ramp type as shown in these details.
8. Curb ramps shall be constructed perpendicular to the roadway travel lane.
9. Coordinate the curb ramp and pedestrian crosswalk markings so a 5'x4' clear space at the base of the curb ramp will fall within the pedestrian crosswalk lines.
10. Set back distance from inside corner of an intersection crosswalk marking to nearest edge of travel lane is 4 feet minimum.
11. Terminate parking a minimum of 20 feet back of a pedestrian crosswalk.
12. Construct a curb ramps a minimum of 5 feet wide. Width may exceed 60" (But should match existing).
13. Construct the running slope of the ramp at a maximum of 8.33% (1:12).
14. Allowable cross slope on sidewalks and ramps to be a maximum of 2%.
15. Construct the side flare slope to a maximum of 10% measured along the curb line.;
16. Construct the counter–slope of the gutter or street at the base of the curb ramp at a maximum of 5% and maintain a smooth transition.
17. Construct landings for sidewalk at a minimum of 5'x5' with a maximum slope of 2% in any direction. Construct landings for median islands a minimum of 5'x5' (or match width of proposed sidewalk) with a maximum slope of 2% in any direction.
18. To use a median island as a pedestrian refuge area, median islands will be a minimum of 6 feet wide. Construct median islands to provide passage over or through the island.
19. Small channelization islands that cannot provide a 5'x5' landing at the top of a curb ramp, will be cut through level with the surface of the street.
20. Curb ramps with returned side curbs may be used only where pedestrians would not normally walk across the ramp such as where there the adjacent surface is plantings, other non–walking surface, or the side approach is substantially obstructed.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD NOTES FOR CURB RAMPS

SCALE:	DETAIL #
Not To Scale	2405.16
REVISION DATE: December, 2022	SHEET #: 1 of 2

STANDARD NOTES (CONTINUED):

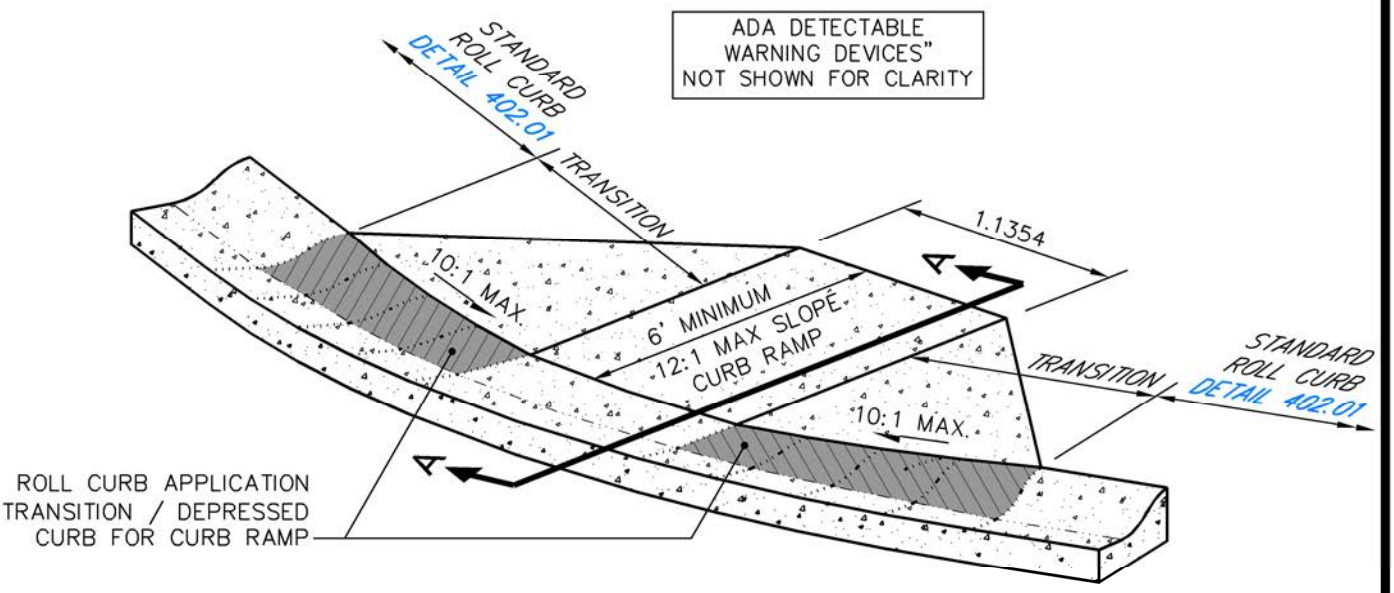
21. The typical 2'x4' truncated dome pad shall be placed with the short dimension perpendicular to the curb. See curb ramp typical details. Truncated dome pads shall abutt the back of the curb (ICC/ANSI A117.1 Fig C406.13.2).
22. Curved truncated dome pads are permitted when ramp width is greater than 4 feet.
23. Color contrast required only when detectable warning plates are employed. (ADA Standards for Accessible Design, section 705, Latest Edition). Recommended Min. light reflectance contrast is 70% (American National Standard ICC/ANSI A117.1 – Standard & Commentary Section 705.3, Latest Edition). Painted surface will not be acceptable. (See note 4). No color contrast is required when detectable warning plates are not used.
24. Place a 1/2–inch expansion joint where the proposed concrete curb ramp joins/abuts the curb &/or sidewalk.
25. Curb ramps through median islands, single ramps at dual crosswalks or limited right–of–way situations will be handled by special details. Consult with the Engineering Director.
26. When construction is on a NCDOT Right–of–Way, construction shall conform to the latest edition of the NCDOT Roadway Standard drawings.
27. Construction of curb ramps shall conform to the latest edition of the ICC/ANSI A117, Chapter 4 Accessible Routes.
28. Curb ramps shall be provided at locations as shown on these plans or as directed by the engineer. Curb ramps shall be located as indicated in these details; however, the location may be adjusted as directed by the engineer where existing light poles, fire hydrants, drop inlets, etc. Affect placement. At these locations, not less than 2 feet of full height curb shall be placed between adjacent ramps.
29. Use air entrained 3000 psi concrete with a sidewalk finish in order to obtain a rough non–skid type surface.
30. Crosswalk widths and configuration vary but must conform to traffic design standards.
31. Place the inside pedestrian crosswalk lines no closer in the intersection then would be established by bisecting the intersection radii, with an allowance of a 4'x4' maneuvering space (2017 ICC/ANSI a117 Commentary. Fig. C406.5.5) in the vehicular travel way when one ramp is installed.
32. Place all pavement markings in accordance with the latest edition of the Manual of Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration and the North Carolina Supplement to the MUTCD.
33. For asphalt greenways transition greenway to concrete to enable truncated dome placement.
34. Concrete must come from a ready mix concrete truck to ensure mix meets air entrainment requirements. No site mix or sakrete mix allowed.
35. Curb ramps require a (4'–0") minimum landing with a maximum cross slope and longitudinal slope of 2.00% where pedestrians perform turning maneuvers. Slope to drain to curb.
36. Taper curb at ramp flares up to either standard curb and gutter or to roll–type curb, as applicable.

TOWN of CLAYTON

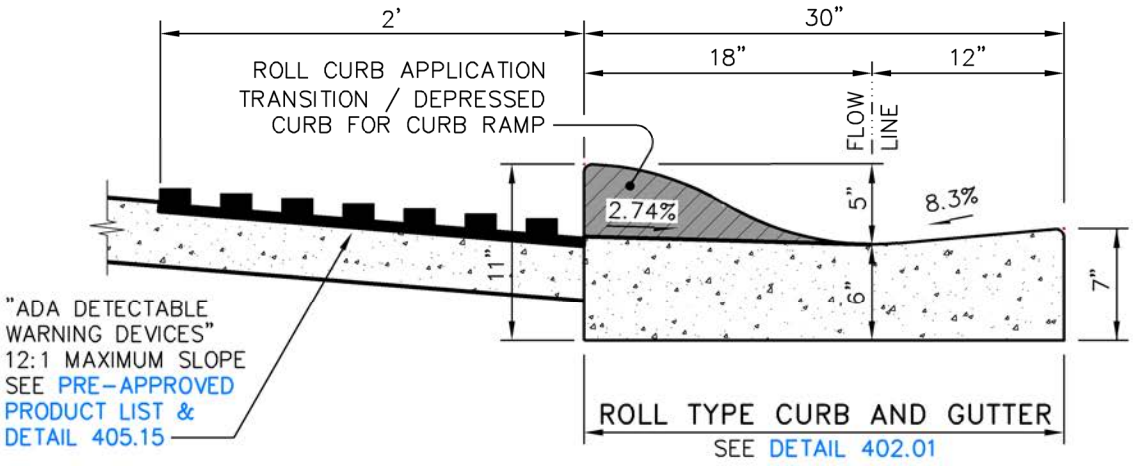
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD NOTES FOR CURB RAMPS

SCALE:	DETAIL #
Not To Scale	2405.16
REVISION DATE: December, 2022	SHEET #: 2 of 2



PERSPECTIVE VIEW



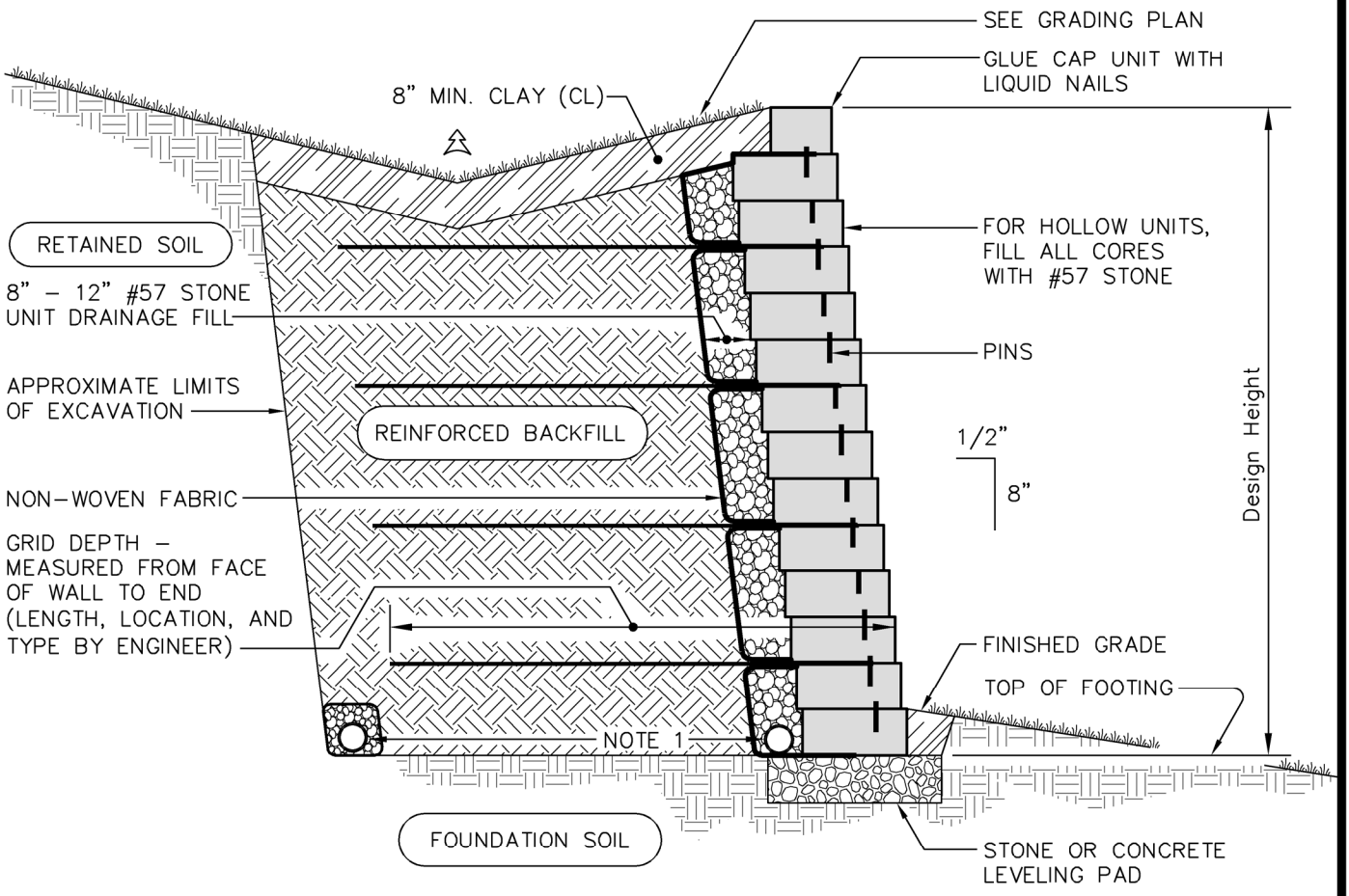
SECTION A-A

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

ROLL CURB TRANSITION ALONG CURB RAMPS

SCALE:	DETAIL #
Not To Scale	405.17
REVISION DATE: December, 2022	SHEET #: 1 of 1



SCHEMATIC SECTION OF TYPICAL GEOGRID REINFORCED SEGMENTAL WALL RETAINING

STANDARD 1/2" SETBACK

NOTES:

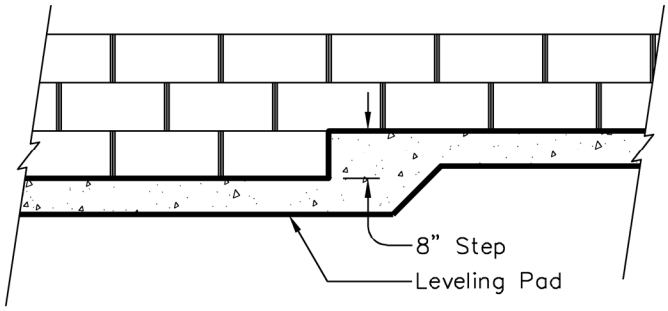
1. Perforated PVC drainage tile in stone wrapped in fabric may be required. Design engineer to make determination if needed and location.
2. Contractor required to obtain a building permit for retaining wall construction.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SEGMENTAL RETAINING WALLS IN R/W (TOWN OF CLAYTON PROJECTS ONLY)

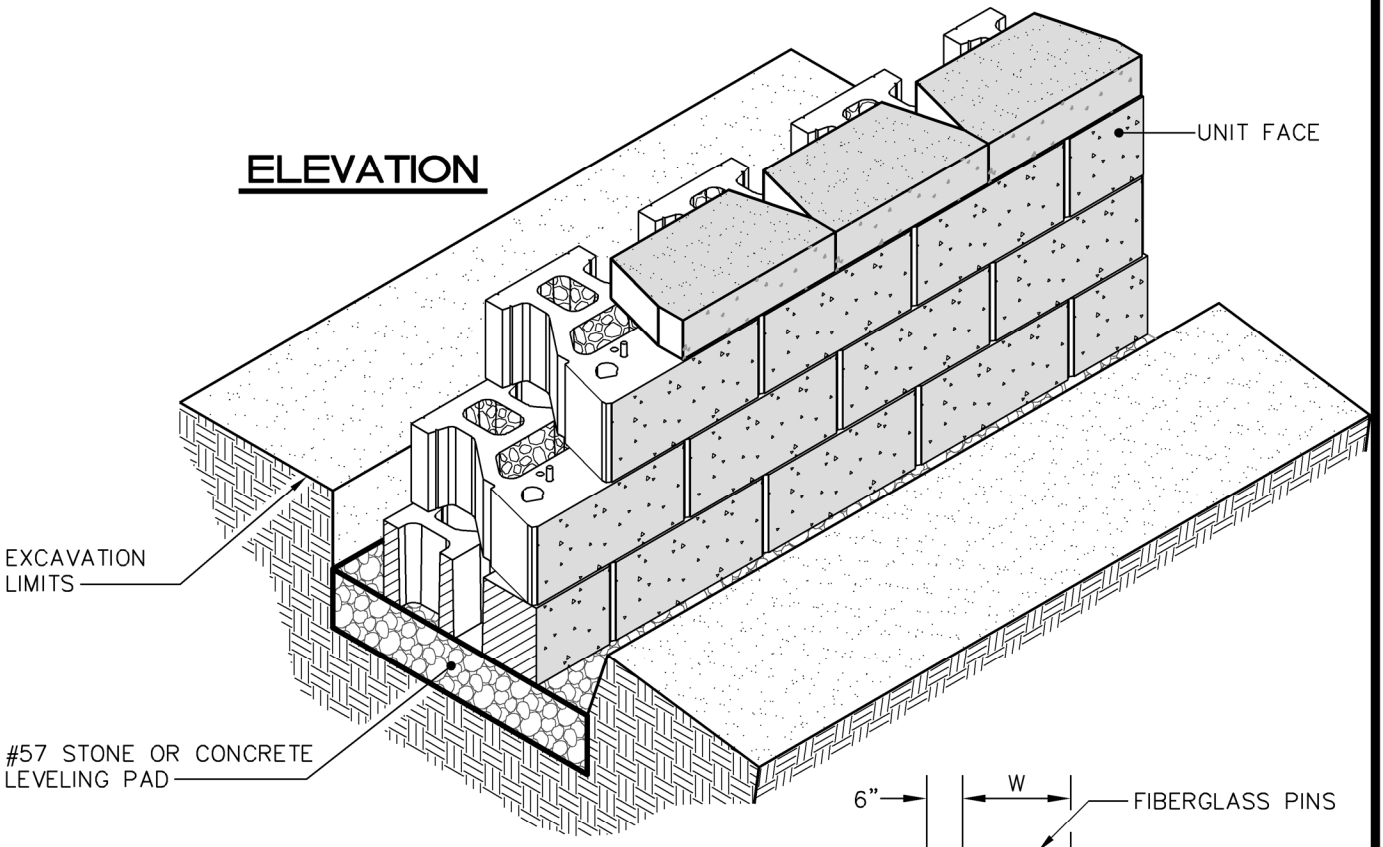
SCALE:	DETAIL #
Not To Scale	2 406.02
REVISION DATE: July, 2023	SHEET #: 1 of 3

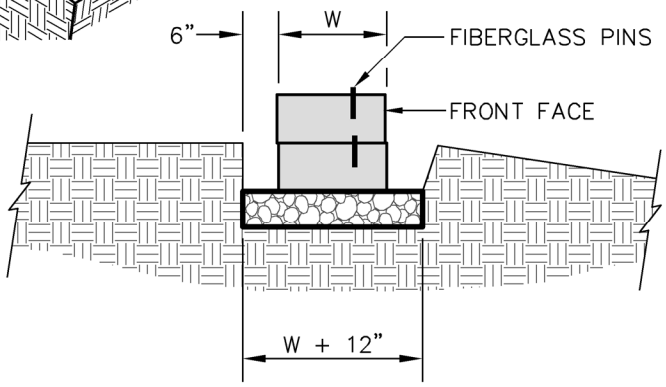


BASE PAD

SHAPE, DIMENSIONS & WEIGHT
VARY BY MANUFACTURER
(KEYSTONE SHOWN)

ELEVATION





SECTION

BASE LEVELING PAD NOTES:

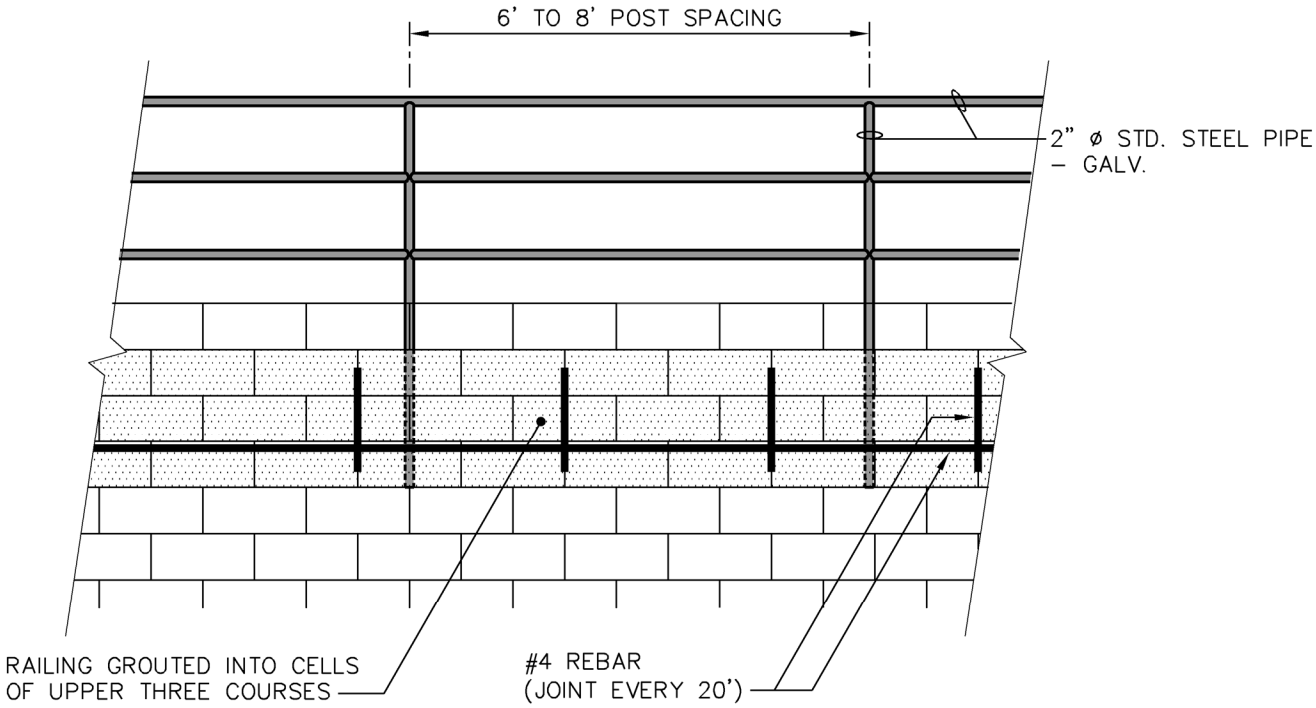
1. The leveling pad is to be constructed of #57 stone or concrete.
2. The leveling pad foundation is to be approved by the engineer prior to placement of the leveling pad.

TOWN of CLAYTON

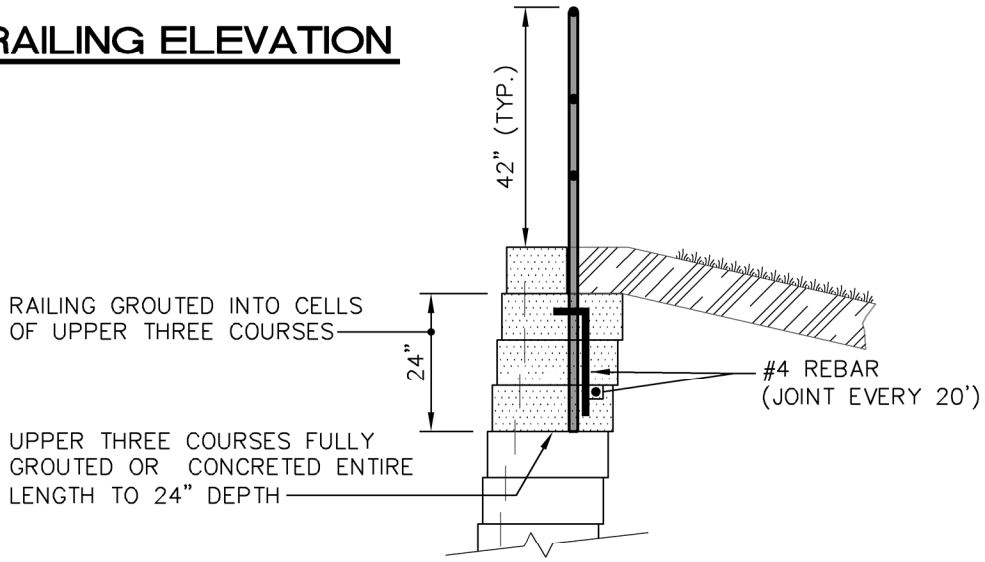
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SEGMENTAL RETAINING WALLS IN RIGHT-OF-WAY

SCALE:	DETAIL #
Not To Scale	406.02
REVISION DATE: December, 2022	SHEET #: 2 of 3



TYPICAL RAILING ELEVATION



STANDARD UNIT SECTION

TYPICAL DIRECT MOUNT RAILING DESIGN

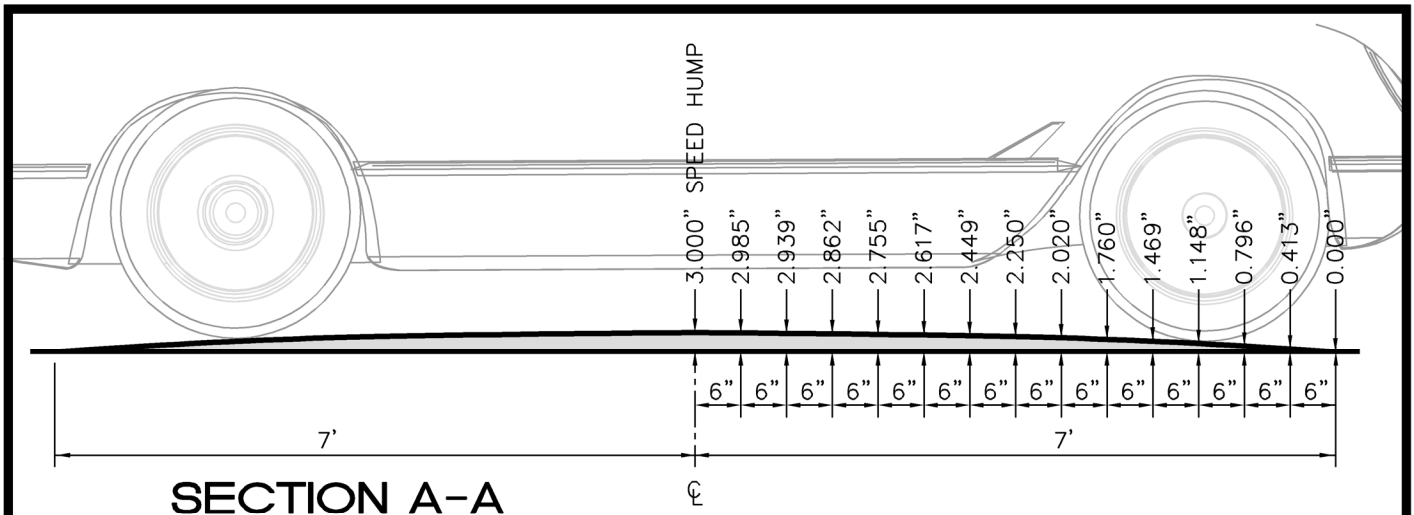
DIRECT MOUNT – 50 PLF LATERAL LIVE LOAD AT TOP OF RAIL

TOWN of CLAYTON

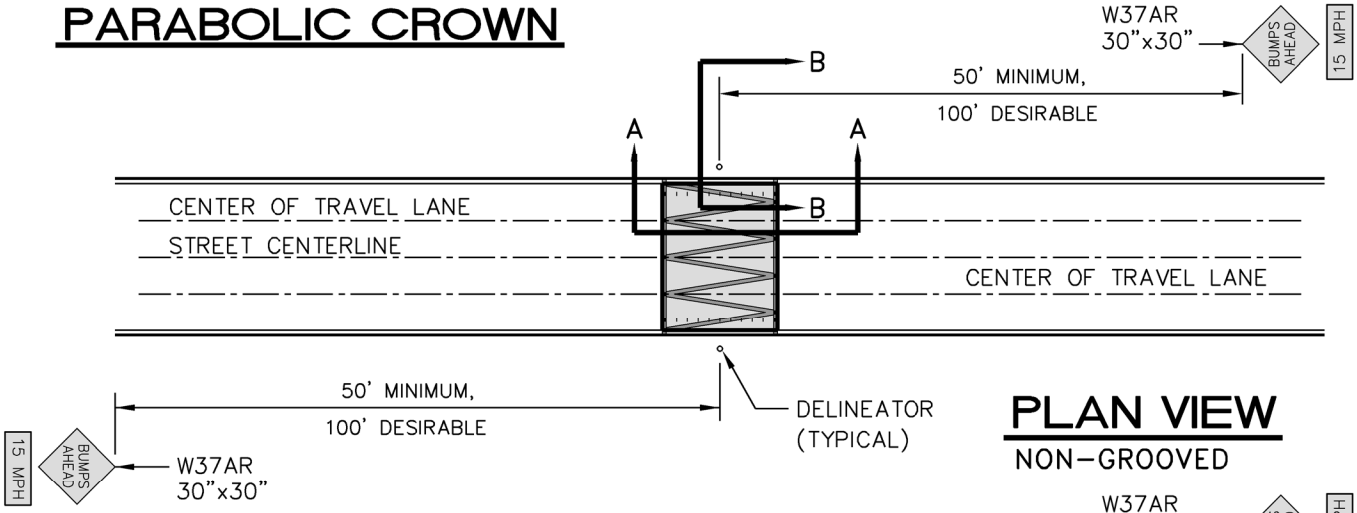
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SEGMENTAL RETAINING WALLS IN RIGHT-OF-WAY

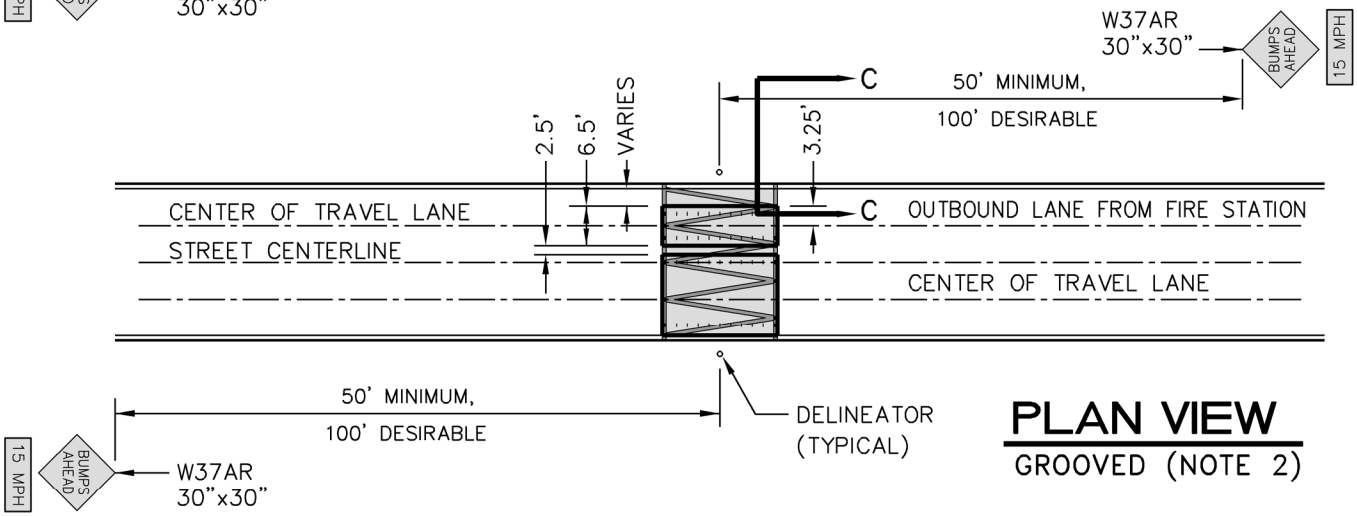
SCALE:	DETAIL #
Not To Scale	2 406.02
REVISION DATE: December, 2022	SHEET #: 3 of 3



SECTION A-A PARABOLIC CROWN



PLAN VIEW
NON-GROOVED



PLAN VIEW
GROOVED (NOTE 2)

NOTES:

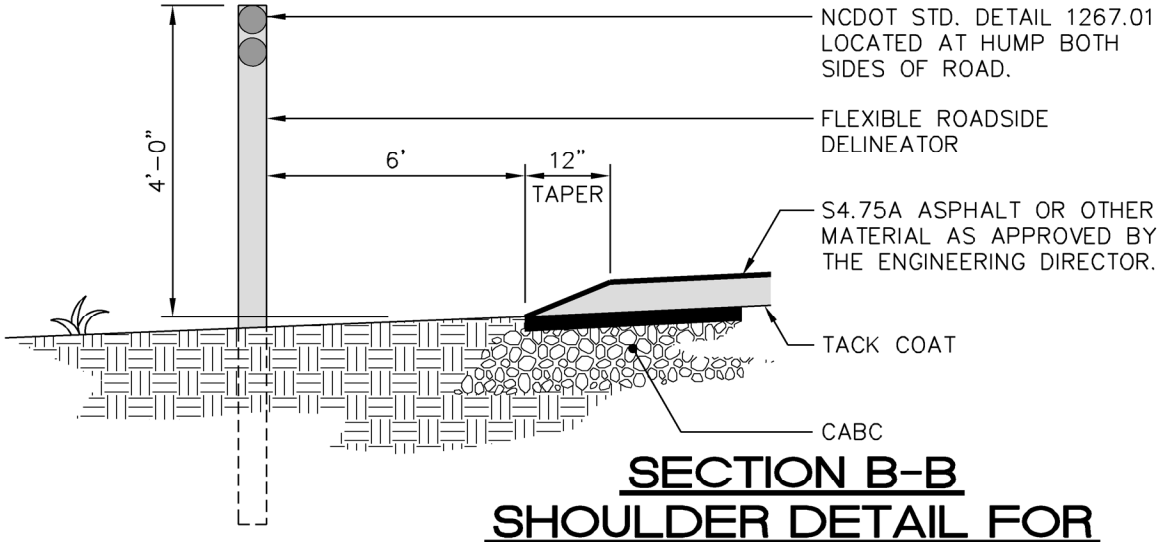
1. Studies show that a 3" speed hump will maintain drivers at 20 to 25 MPH
2. Application of hump grooving to be determined by Fire Department.

TOWN of CLAYTON

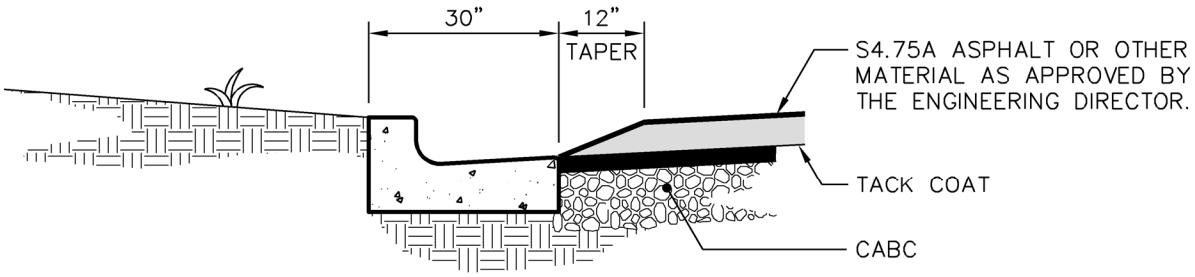
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

14' SPEED HUMP INSTALLATION DETAIL

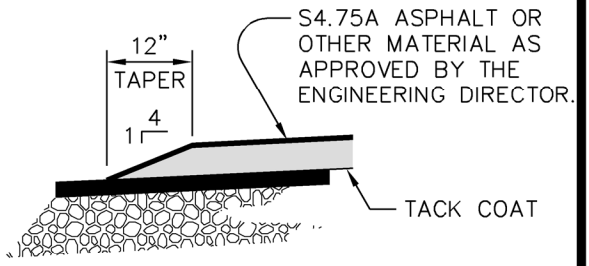
SCALE:	DETAIL #
Not To Scale	2407.01
REVISION DATE: December, 2022	SHEET #: 1 of 2



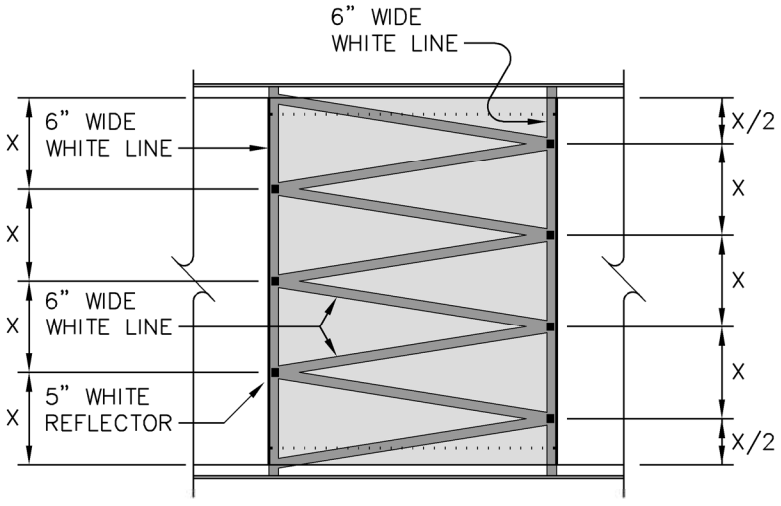
SECTION B-B SHOULDER DETAIL FOR STREETS WITHOUT CURBS



SECTION B-B CURB DETAIL



SECTION C-C



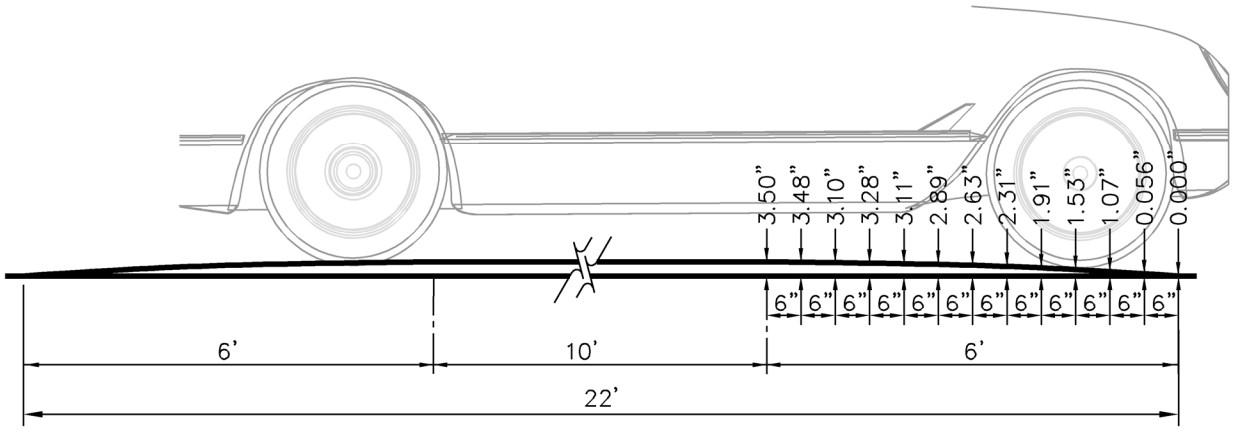
MARKING FOR HUMP

TOWN of CLAYTON

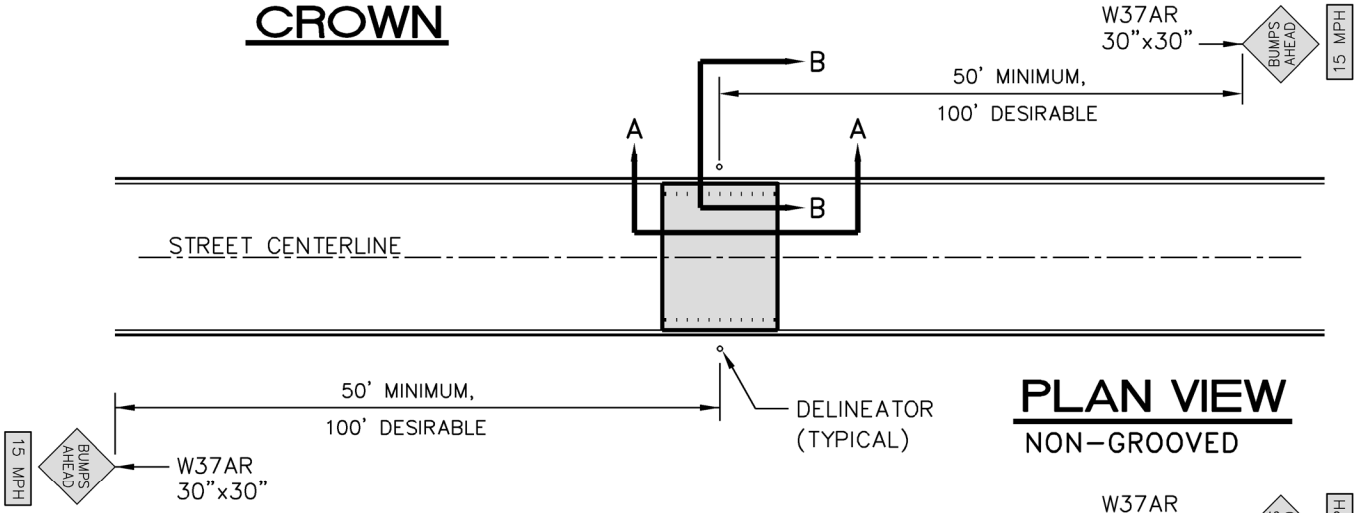
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

14' SPEED HUMP INSTALLATION DETAIL

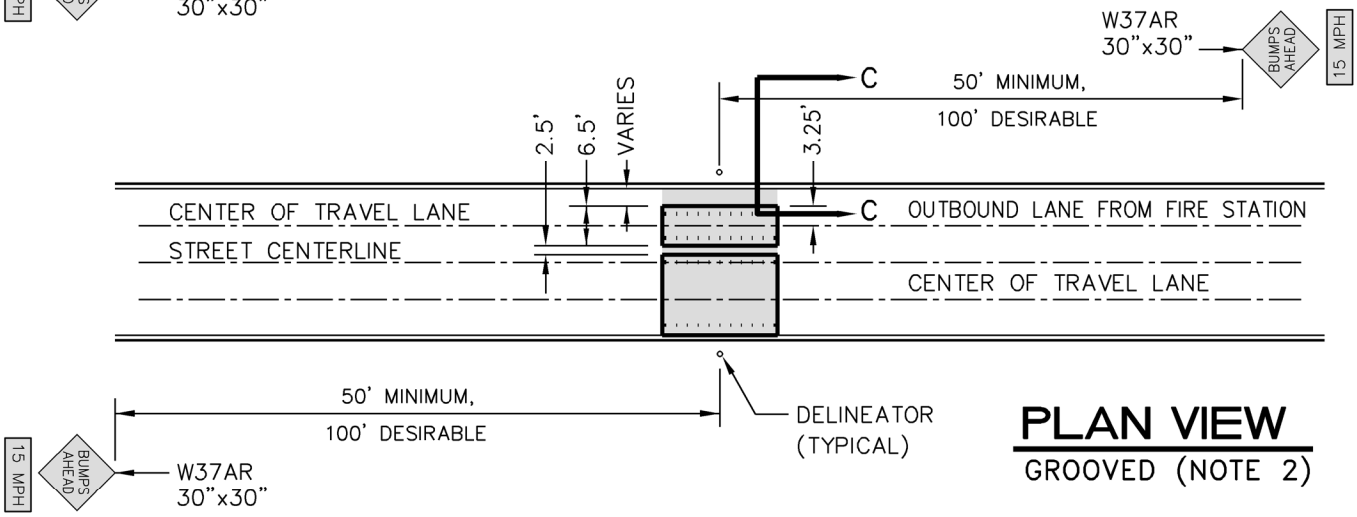
SCALE:	DETAIL #
Not To Scale	2407.01
REVISION DATE: December, 2022	SHEET #: 2 of 2



SECTION A-A CROWN



PLAN VIEW
NON-GROOVED



PLAN VIEW
GROOVED (NOTE 2)

NOTES:

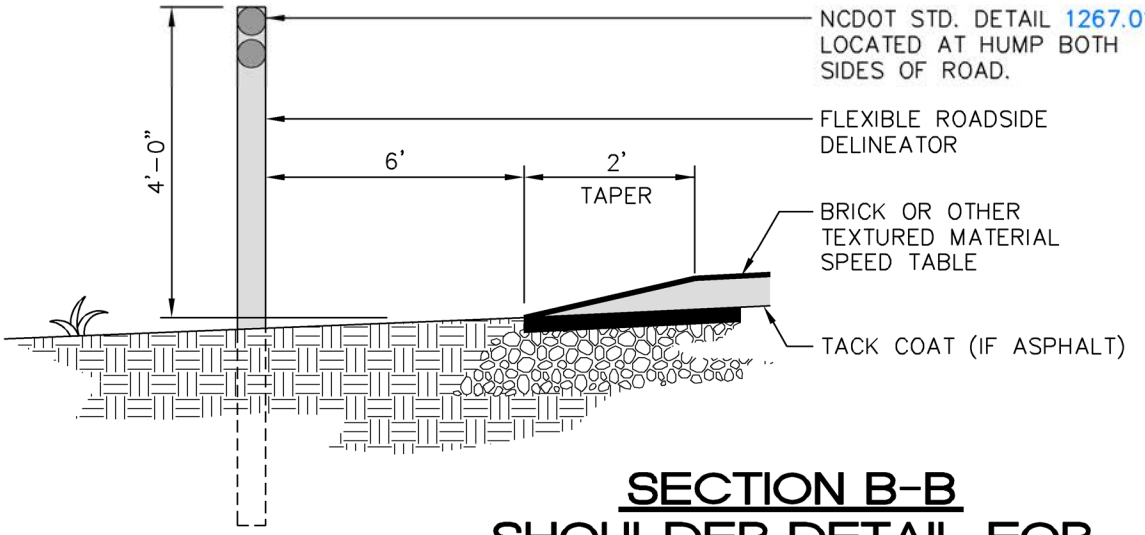
1. Drainage requirements must be evaluated and addressed.
2. Application of hump grooving to be determined by Fire Department.

TOWN of CLAYTON

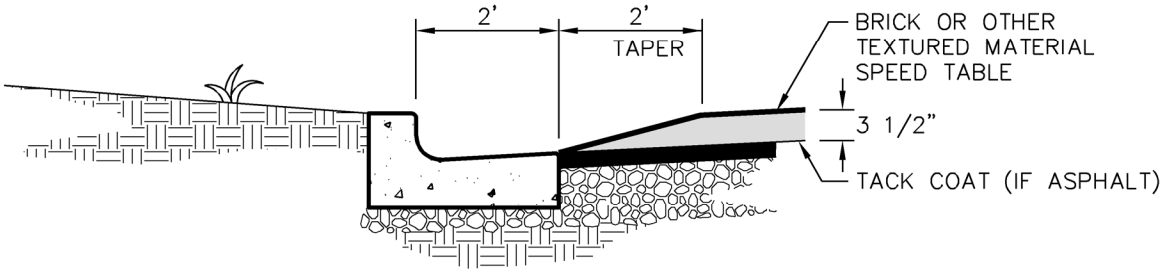
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SPEED TABLE INSTALLATION DETAIL

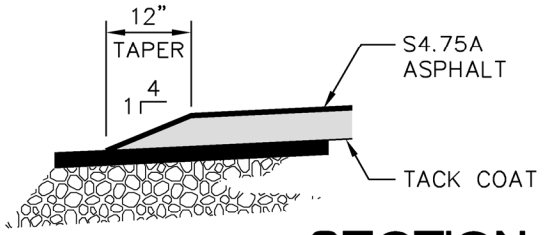
SCALE:	DETAIL #
Not To Scale	407.02
REVISION DATE: December, 2022	SHEET #: 1 of 2



SECTION B-B
SHOULDER DETAIL FOR STREETS WITHOUT CURBS



SECTION B-B
CURB DETAIL



SECTION C-C

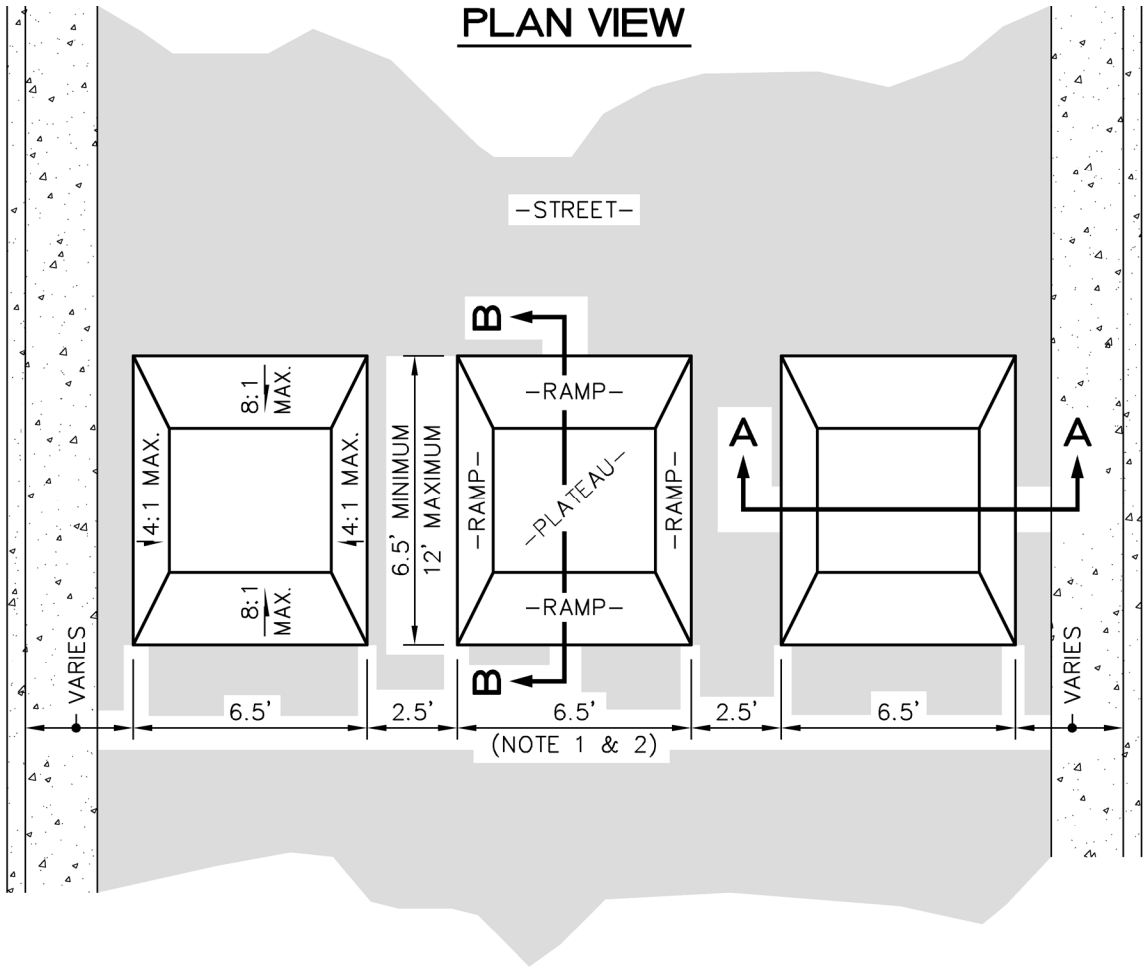
TOWN of CLAYTON

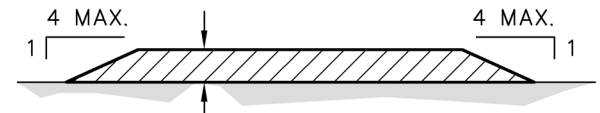
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SPEED TABLE INSTALLATION DETAIL

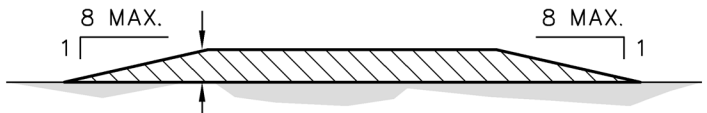
SCALE:	DETAIL #
Not To Scale	2407.02
REVISION DATE: December, 2022	SHEET #: 2 of 2

PLAN VIEW





SECTION A-A



SECTION B-B

NOTES:

1. Less widths may result in cars being able to straddle the cushion & increasing chance of grounding on top of cushion.
2. Spacing between cushions to be 225' to 350' maximum for an average reduction in speed of 10 MPH for cushions 6.5' wide, and around 5 MPH for cushions 5.25' wide. For frequent fire apparatus routes, limit cushion width to 5.25'.
3. Speed Cushions require approval of fire department.

TOWN of CLAYTON

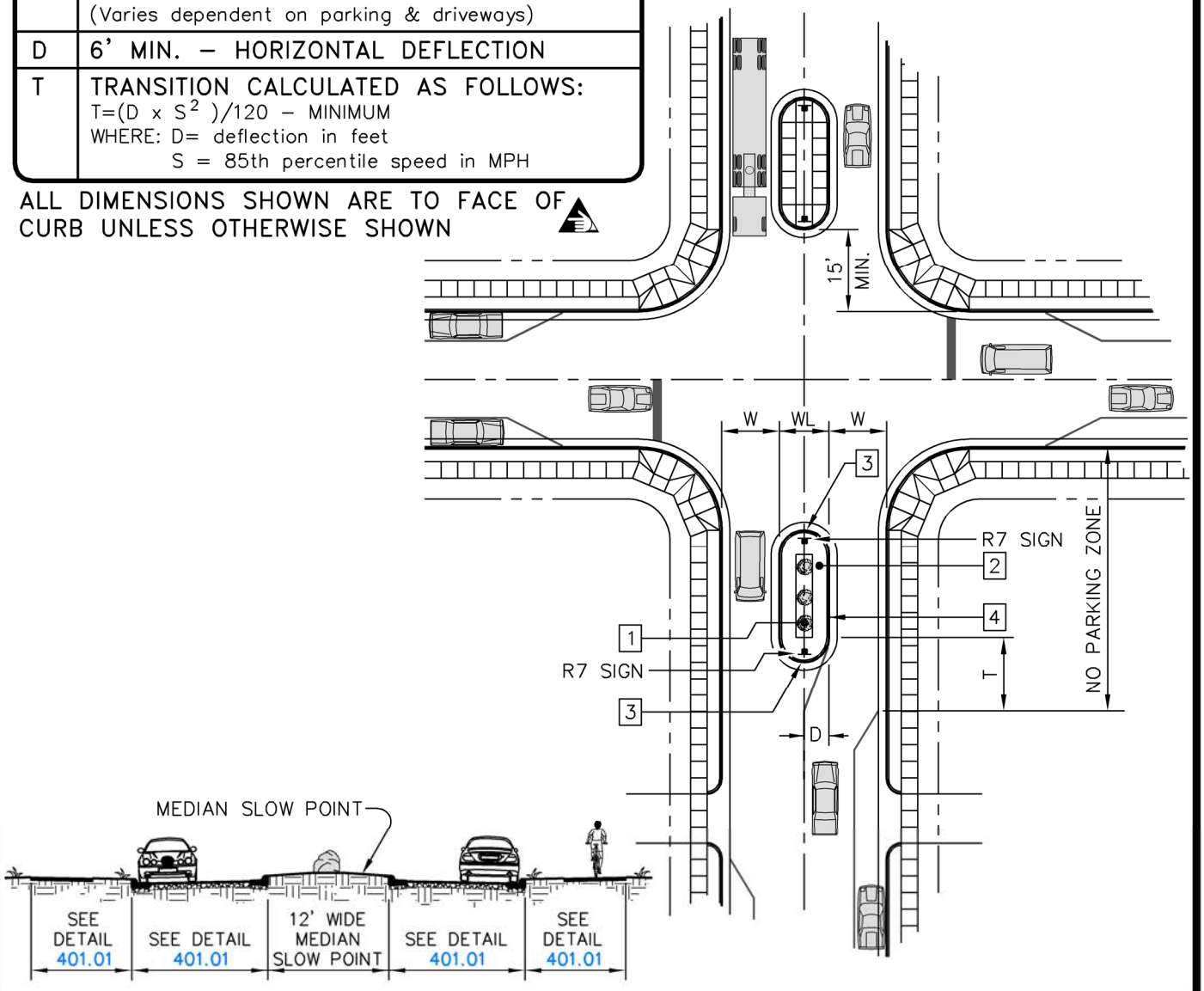
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SPEED CUSHION INSTALLATION DETAIL

SCALE:	DETAIL #
Not To Scale	407.03
REVISION DATE: December, 2022	SHEET #: 1 of 1

1	AREA THAT MAY BE LANDSCAPED 1. Landscape, irrigation, and long term maintenance must be covered by a maintenance agreement, an encroachment agreement and other such agreements as determined by the Town 2. With Town of Clayton's permission, object marker, sculpture, or Town approved amenity may be placed in island
2	4" THICK STAMPED CONCRETE
3	YELLOW PAINTED ISLAND NOSE
4	MEDIAN CURB & GUTTER (DETAIL 402.01)
W	10' – TRAVEL LANE WIDTH
WL	12' MIN. – WIDTH OF SLOW POINT (Varies dependent on street width)
L	LENGTH OF SLOW POINT (Varies dependent on parking & driveways)
D	6' MIN. – HORIZONTAL DEFLECTION
T	TRANSITION CALCULATED AS FOLLOWS: $T=(D \times S^2)/120$ – MINIMUM WHERE: D= deflection in feet S = 85th percentile speed in MPH

ALL DIMENSIONS SHOWN ARE TO FACE OF CURB UNLESS OTHERWISE SHOWN



TOWN of CLAYTON

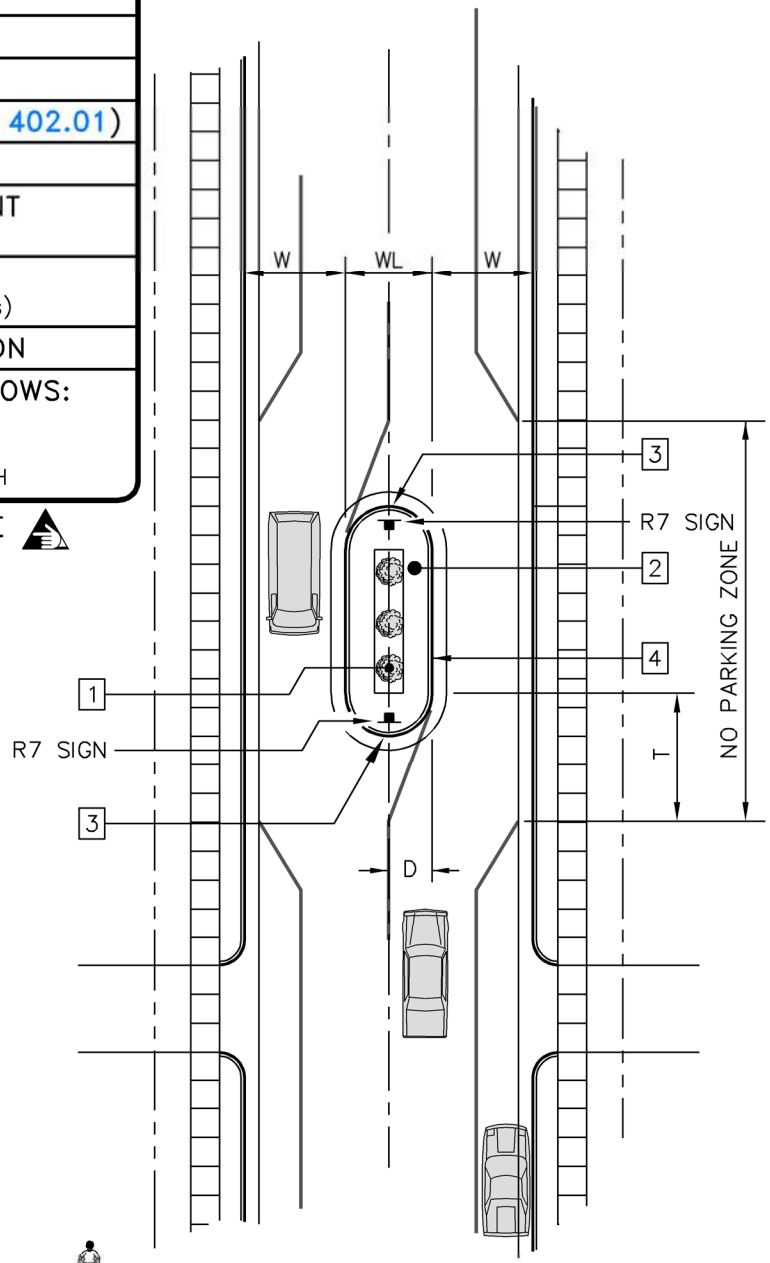
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

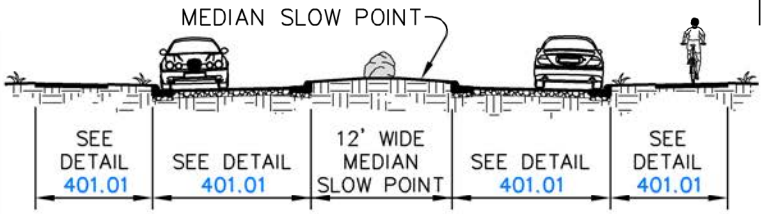
TRAFFIC CALMING MEDIAN SLOW POINT

SCALE: Not To Scale	DETAIL # 407.04
REVISION DATE: July, 2023	SHEET #: 1 of 2

1	AREA THAT MAY BE LANDSCAPED 1. Landscape, irrigation, and long term maintenance must be covered by a maintenance agreement, an encroachment agreement and other such agreements as determined by the Town 2. With Town of Clayton's permission, object marker, sculpture, or Town approved amenity may be placed in island
2	4" THICK STAMPED CONCRETE
3	YELLOW PAINTED ISLAND NOSE
4	MEDIAN CURB & GUTTER (DETAIL 402.01)
W	10' – TRAVEL LANE WIDTH
WL	12' MIN. – WIDTH OF SLOW POINT (Varies dependent on street width)
L	LENGTH OF SLOW POINT (Varies dependent on parking & driveways)
D	6' MIN. – HORIZONTAL DEFLECTION
T	TRANSITION CALCULATED AS FOLLOWS: $T=(D \times S^2)/120$ – MINIMUM WHERE: D= deflection in feet S = 85th percentile speed in MPH

ALL DIMENSIONS SHOWN ARE TO FACE OF CURB UNLESS OTHERWISE SHOWN



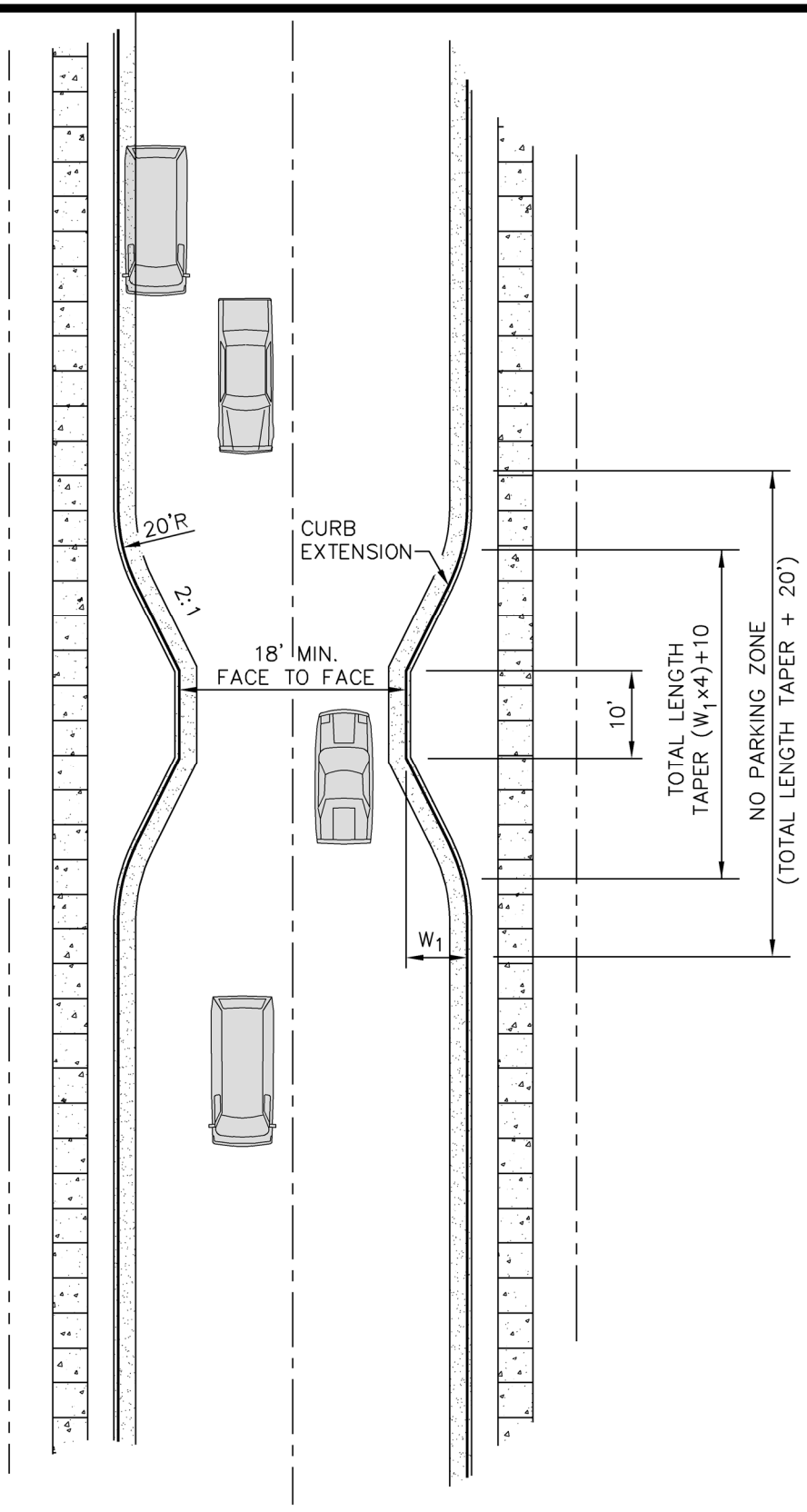


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TRAFFIC CALMING MEDIAN SLOW POINT

SCALE: Not To Scale	DETAIL # 407.04
REVISION DATE: July, 2023	SHEET #: 2 of 2



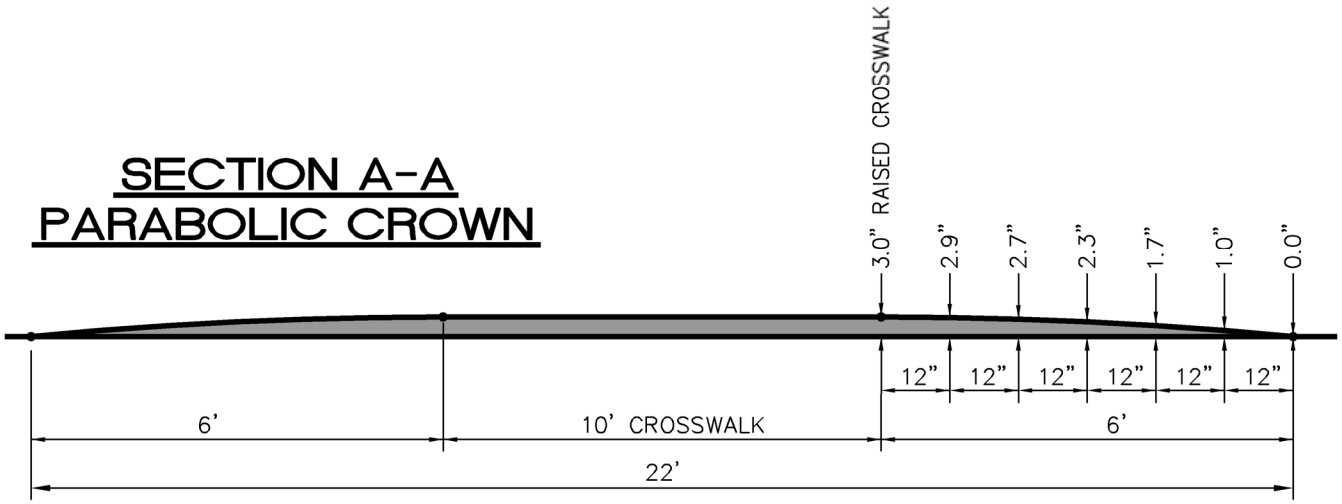
TOWN of CLAYTON

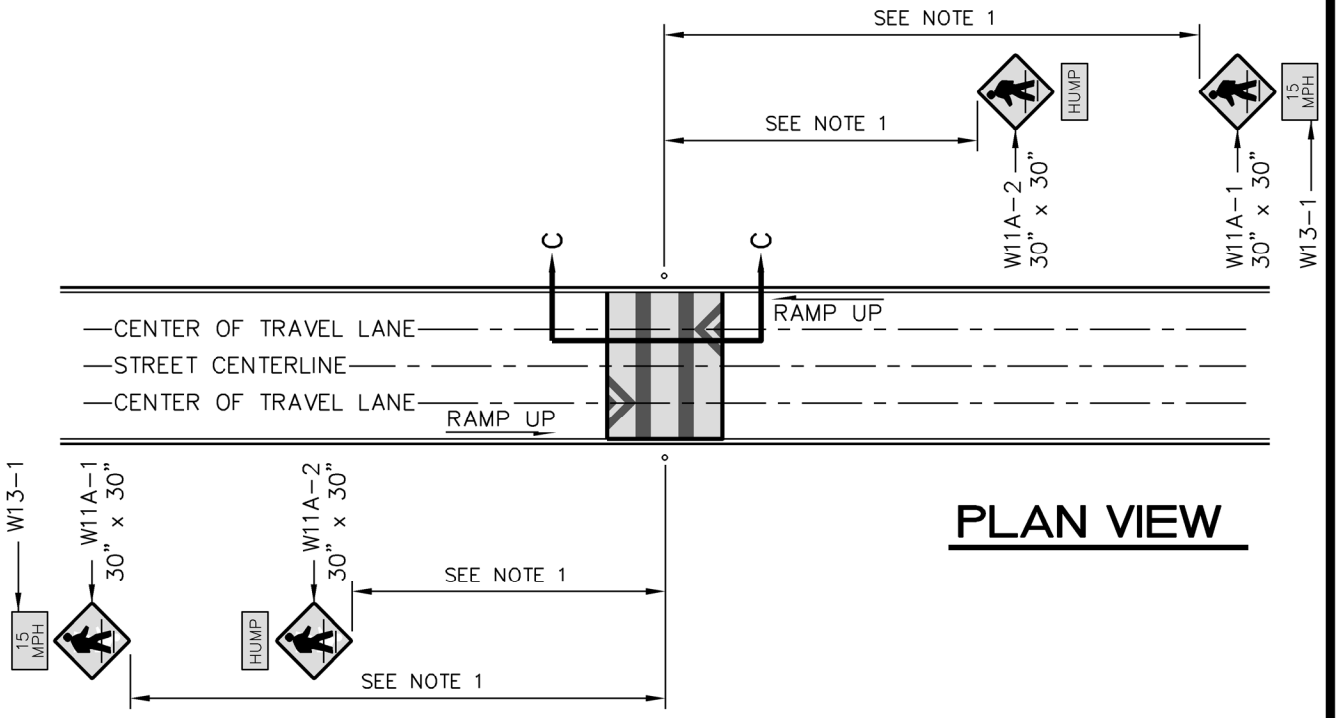
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TRAFFIC CALMING CHOKER POINT

SCALE:	DETAIL #
Not To Scale	2 407.06
REVISION DATE: December, 2022	SHEET #: 1 of 1

SECTION A-A
PARABOLIC CROWN





PLAN VIEW

NOTES:

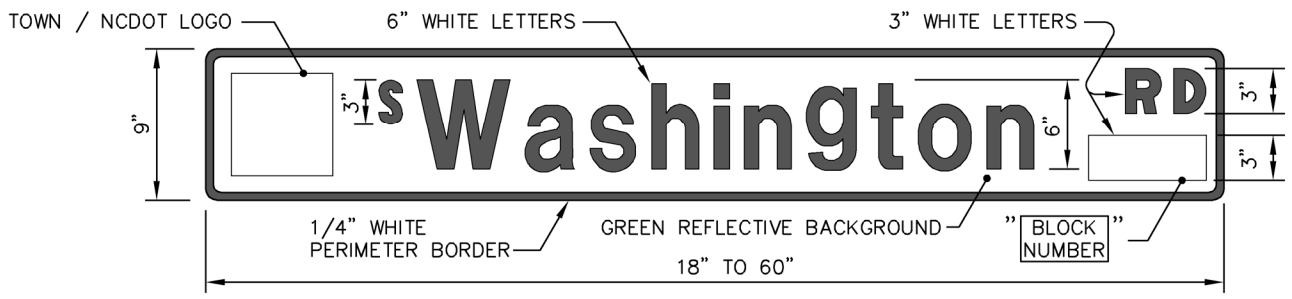
1. Signs and Markings shall be in accordance with the MUTCD.
2. Raised Crosswalks shall be located mid-block (edge of ramp at least 20' from intersection) and shall not be placed over manholes, gate valves, junction boxes, etc.

TOWN of CLAYTON

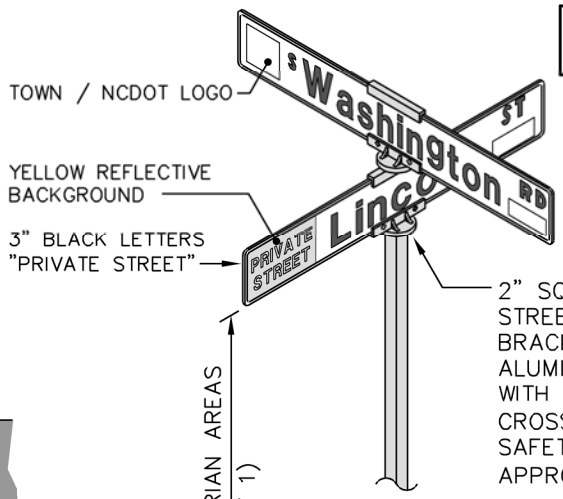
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

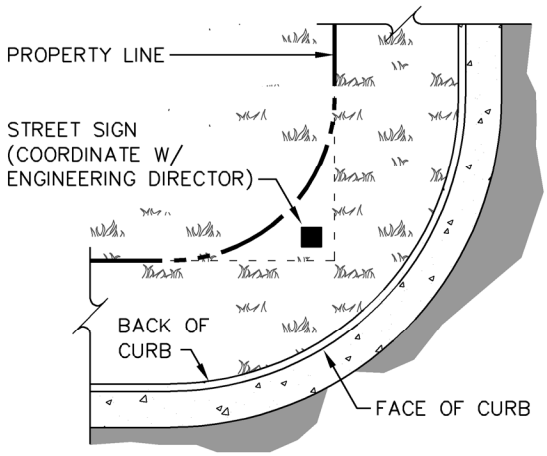
RAISED CROSSWALK INSTALLATION DETAIL

SCALE:	DETAIL #
Not To Scale	407.07
REVISION DATE: December, 2022	SHEET #: 1 of 1

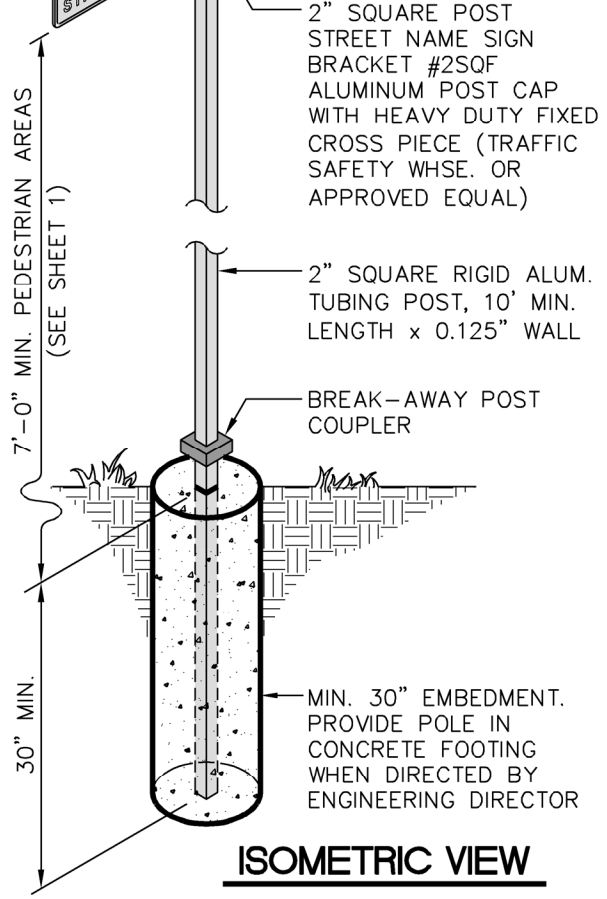


4 WAY STREET SIGN SHOWN





PLAN VIEW



ISOMETRIC VIEW

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD SIGN INSTALLATION DETAIL

SCALE:	DETAIL #
Not To Scale	2 407.08
REVISION DATE:	SHEET #:
July, 2023	1 of 2

NOTES:

1. Street Names: 3" and 6" white with green overlay with lower case after first letter; standard Arial, FHWA Highway Gothic font, or approved equal on both sides of blades.
2. Sign Fabrication:
   a. All signs shall be fabricated from High Intensity Prismatic Grade Reflective Green Sheeting and meet USDOT FHA ASTM D4956 current standards, Type IV (AASHTO M268 Type B) and have a minimum of a 10 year service life. Type VIII, IX or XI are acceptable reflective sheeting type alternatives.
   b. Bordered sign blades are required.
   c. All sign face sheeting material should be reflectorized and affixed to both sides of the sign blank. Blades should be white with green overlay. Provide Diamond Grade reflectorized sheeting for major arterials – match nomenclature for street sections above collector. The Engineering Director shall approve any deviation from the details.
3. Private Road/Lane Designation:
   a. Private Street background to be FHWA MUTCD yellow #FFCC00 rgb(255, 204, 0) (https://mutcd.fhwa.dot.gov/kno-colorspec.htm). See sign schematic.
   b. Letters shall be 3-inch black letters
4. Aluminum sign blanks materials to be 0.080" thick with extruded aluminum blades.
5. Decorative Posts: Developer or HOA may submit a request for the use of decorative posts with street signs to the Engineering Director for approval. The develop or HOA would be solely responsible for installation, maintenance, and/or replacement costs associated with the posts. If decorative post become unavailable for replacement, the developer or HOA would be responsible for the change out to posts meeting the Town of Clayton specifications.

RECOMMENDED INSTALLATION

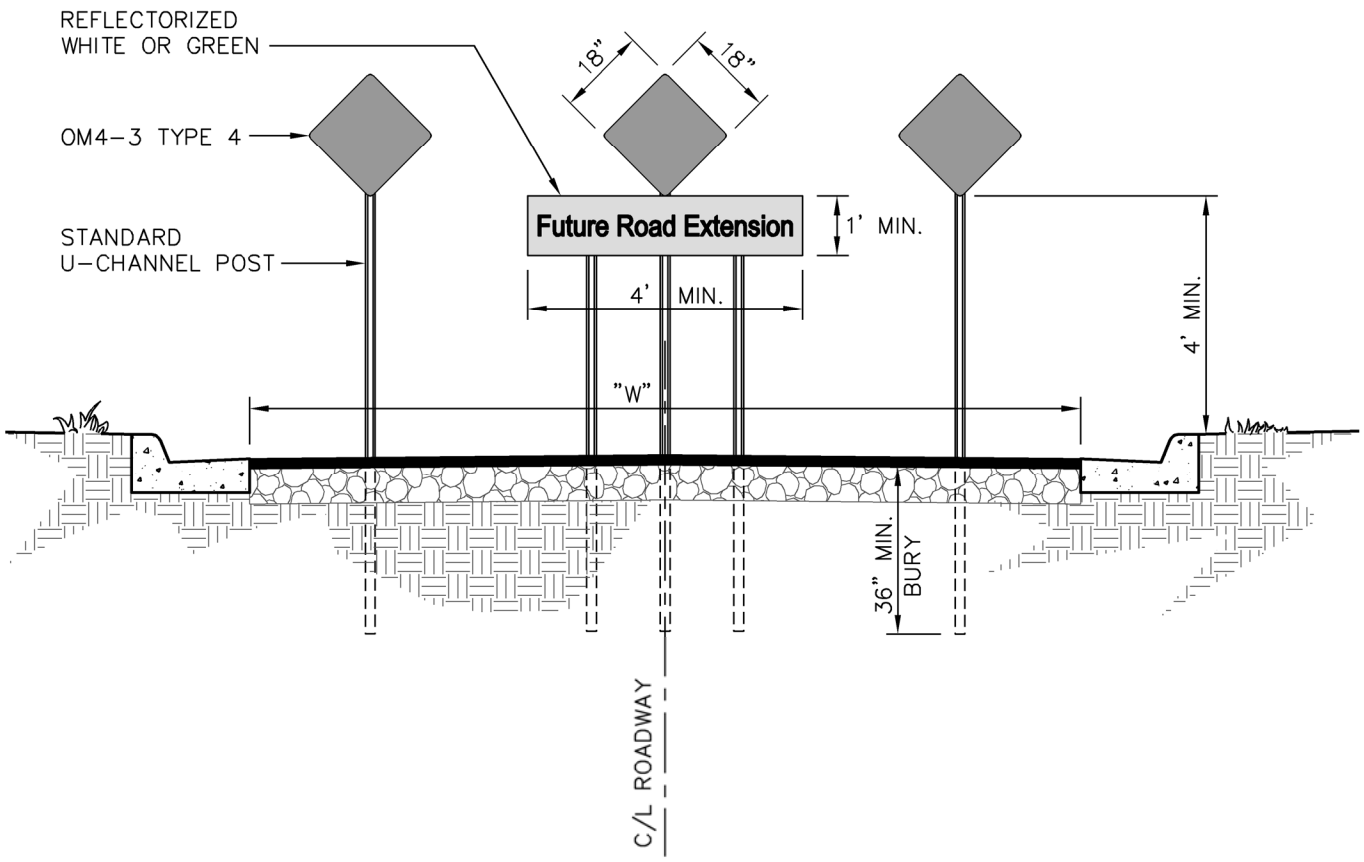
1. Street name sign to be one-foot from property line if said lines were extended.
2. Sign blades not to extend past back of curb into road.
3. Sign location to be placed on low side of block numbering.
4. Any exceptions shall be approved by the Engineering Director.
5. Developer responsible for installation of all street signs. Submit sign proofs for approval prior to installation.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD SIGN INSTALLATION DETAIL

SCALE:	DETAIL #
Not To Scale	2 407.08
REVISION DATE: July, 2023	SHEET #: 2 of 2



NOTES:

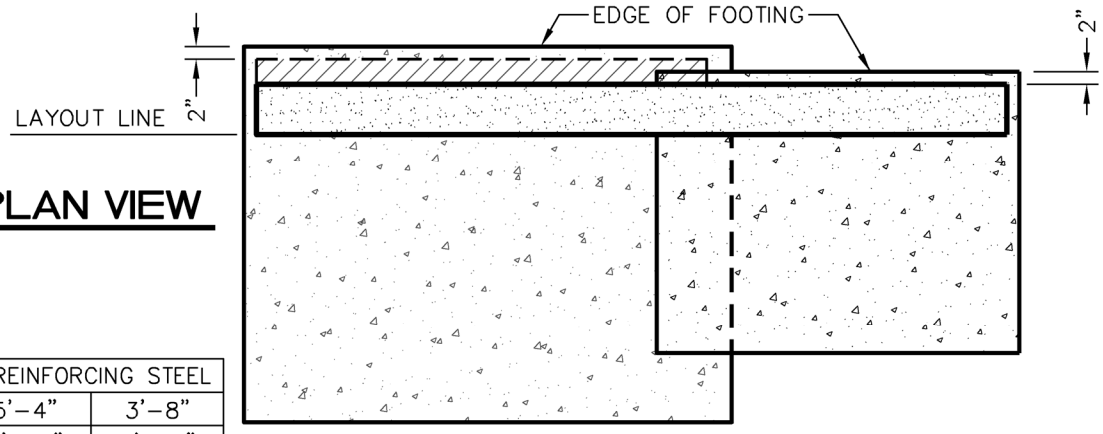
1. OM4–3 signs should be evenly spaced between curb and gutter.
2. Spacing shall be adjusted for wider roadways. Additional signage may be required.
3. Advance warning sign W14–2 (No Outlet) shall be placed after the last intersection.
4. If subdivision has no additional exits, advance signage shall be placed at entrance(s).

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

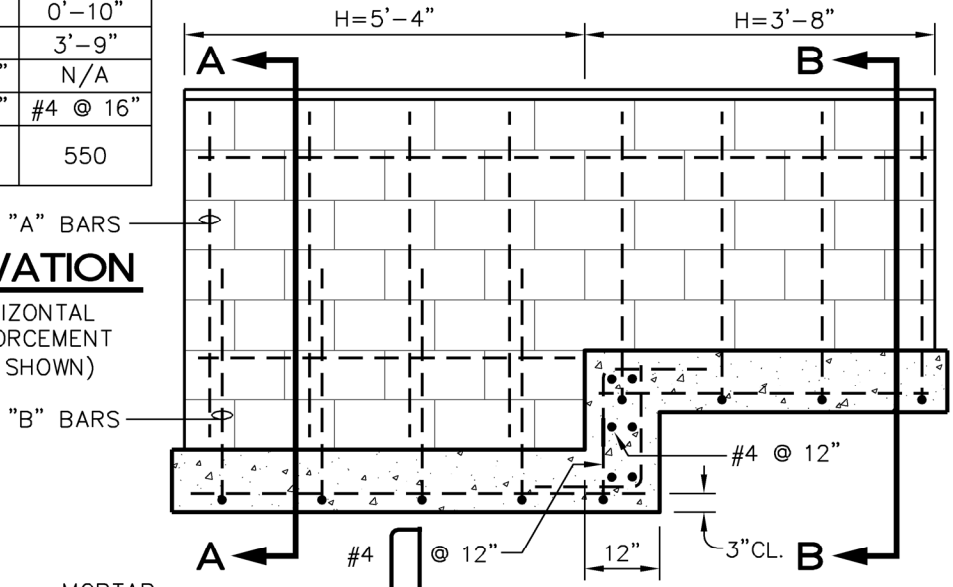
TEMPORARY END OF ROAD SIGNAGE DETAIL

SCALE:	DETAIL #
Not To Scale	2407.09
REVISION DATE: December, 2022	SHEET #: 1 of 1



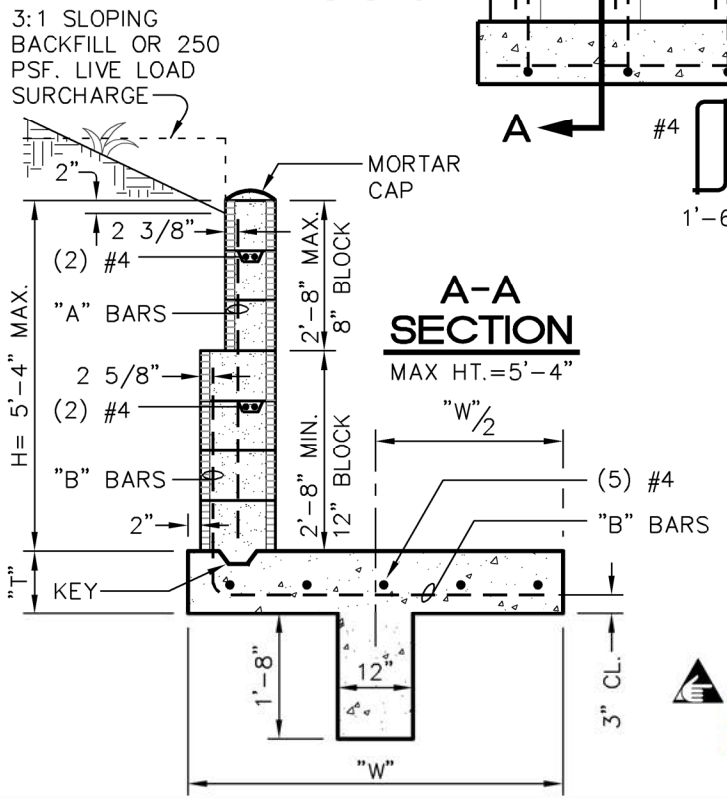
PLAN VIEW

DIMENSIONS and REINFORCING STEEL		
H (MAX)	5'–4"	3'–8"
T (MIN)	0'–10"	0'–10"
W (MIN)	5'–0"	3'–9"
"A" BARS	#4 @ 16"	N/A
"B" BARS	#6 @ 16"	#4 @ 16"
MAX. TOE PRESS. (PSF)	700	550



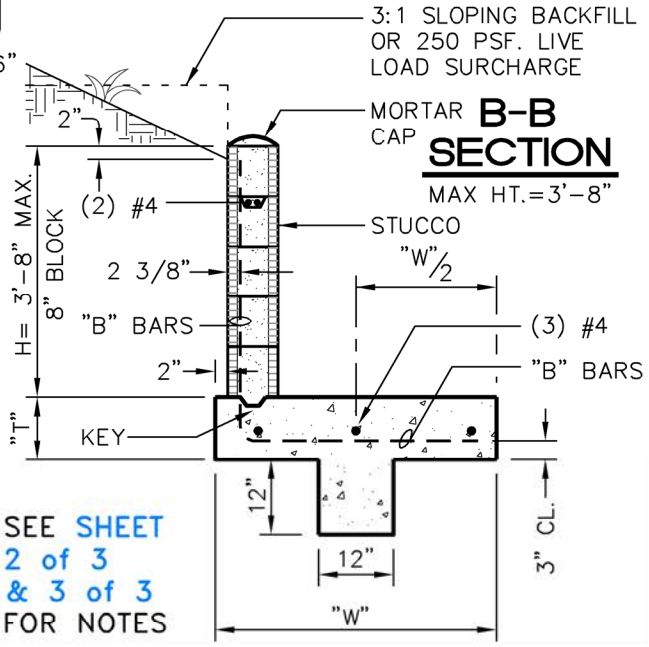
ELEVATION

(HORIZONTAL REINFORCEMENT NOT SHOWN)



A-A SECTION

MAX HT.=5'–4"



B-B SECTION

MAX HT.=3'–8"

SEE SHEET 2 of 3 & 3 of 3 FOR NOTES

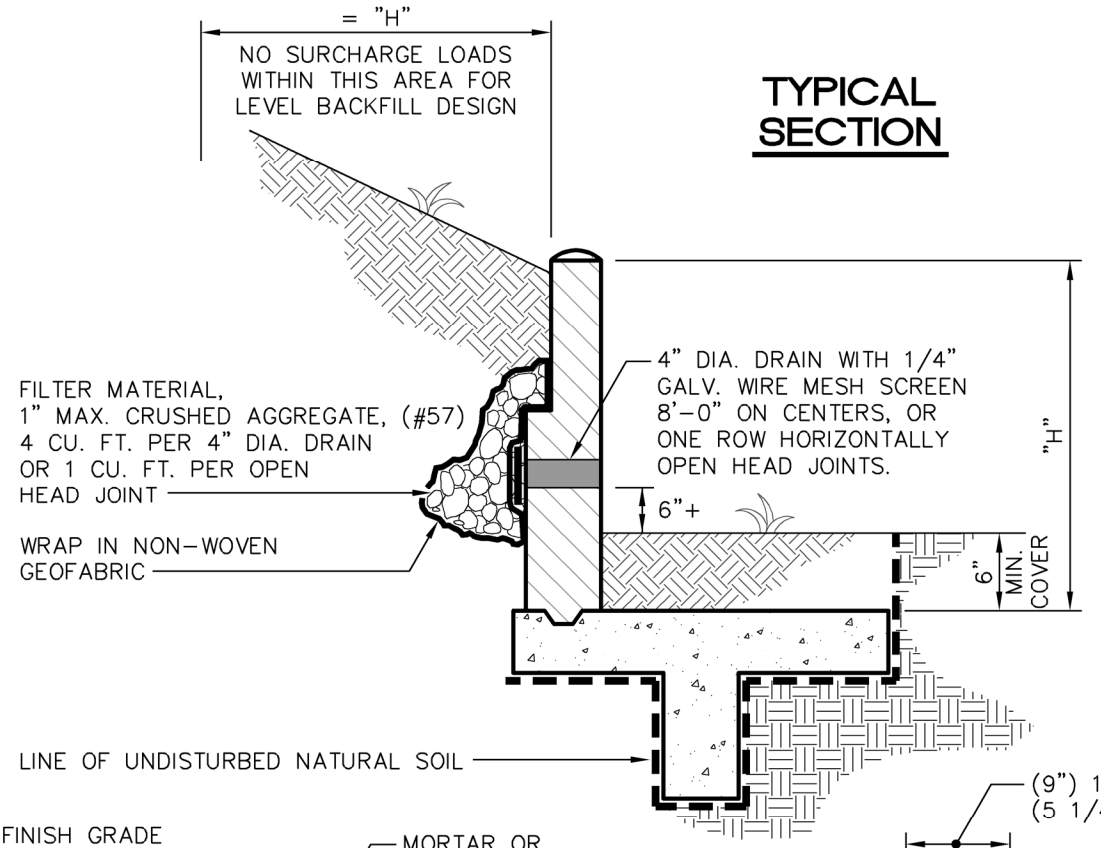
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

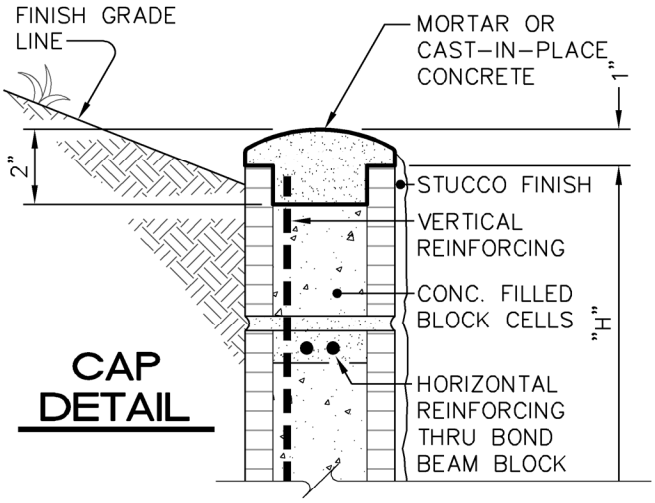
TYPICAL MASONRY RETAINING WALL

SCALE: Not To Scale	DETAIL # 2 408.02
REVISION DATE: December, 2022	SHEET #: 1 of 3

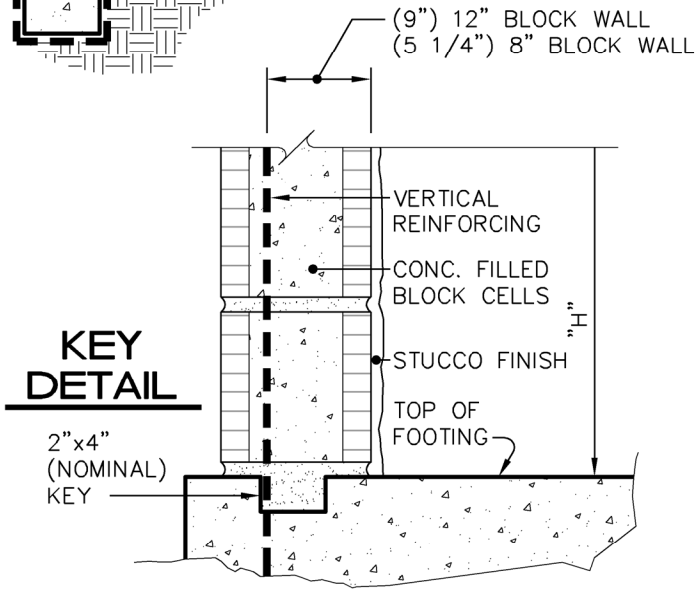
TYPICAL SECTION



CAP DETAIL



KEY DETAIL



NOTES:

1. All masonry retaining walls shall be constructed with cap, key, and drainage details as shown heron.
2. Fill all block cells solid w/3,000 psi concrete with pea gravel aggregate. Maximum vertical lift of cell fill = 4'-0".
3. Max. length of wall without vertical expansion joint shall be 60'.
4. Steps in footing shall be in modular 8" increments.
5. Do not permit horizontal reinforcement to cross vertical expansion joints.
6. The Town of Clayton will accept other type walls (Masonry segmental retaining walls, Gravity) if plans are prepared and sealed by a NC PE.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL MASONRY RETAINING WALL

SCALE:	DETAIL #
Not To Scale	2408.02
REVISION DATE: December, 2022	SHEET #: 2 of 3

CONCRETE

1. All concrete shall be 3,000 psi.

FINISH

1. Place a stucco finish on wall face.

DESIGN CONDITIONS

1. Walls are to be used for the loading conditions shown for each type wall.
2. Design H shall not be exceeded.
3. Footing key is required except as shown otherwise or when found unnecessary by the Engineering Director.
4. Special footing design is required where foundation material is incapable of supporting toe pressure listed in table.

DESIGN DATA

Reinforced Masonry:
F'm = 600 psi
Fm = 200 psi
Fs = 20,000 psi
n = 50
Earth = 120 pcf and equivalent fluid
pressure = 36 psf per foot of height

Reinforced Concrete:
F'c = 3000 psi
Fs = 20,000 psi
n = 50

walls shown for 1 –1/2:1 unlimited sloping surcharge are designed in accordance with Rankine's formula for unlimited sloping surcharge with ø = 33°–42'

REINFORCEMENT

1. Conform to ASTM A615, Grade 60.
2. Bars shall lap 40 diameters, where spliced, unless otherwise shown on the plans.
3. Bends shall conform to the Manual of Standard practice, A.C.I.
4. Backing for hooks is four diameters.
5. All bar embedment's are clear distances to outside of bar.
6. Spacing for parallel bars is center to center of bars.

MASONRY

1. All reinforced masonry retaining walls shall be constructed of regular weight standard grade "A" units conforming to ASTM designation C–90 and manufactured in accordance with requirements of the Concrete Masonry Association Specifications. All masonry shall conform to the regulations of the NC Building Code.

MASONRY MORTAR

1. The mortar shall be type S or M.
2. Mortar in horizontal joints shall fully cover all face shell and web members. Vertical joints shall be buttered to a depth greater than the thickness of the face shells of the block. Furrowing of mortar will not be permitted.

EXCAVATION AND BACKFILL

1. Compaction of backfill material by jetting or ponding with water will not be permitted. Each layer of backfill shall be moistened as directed by the Engineer and thoroughly tamped, rolled or otherwise compacted until the relative compaction is not less than 90%.
2. No backfill material shall be deposited against masonry retaining walls until the grout has developed a strength of 2,000 pounds per square inch in compression as determined by test 2" cubes, or until the masonry retaining wall has cured for a minimum of 14 days.

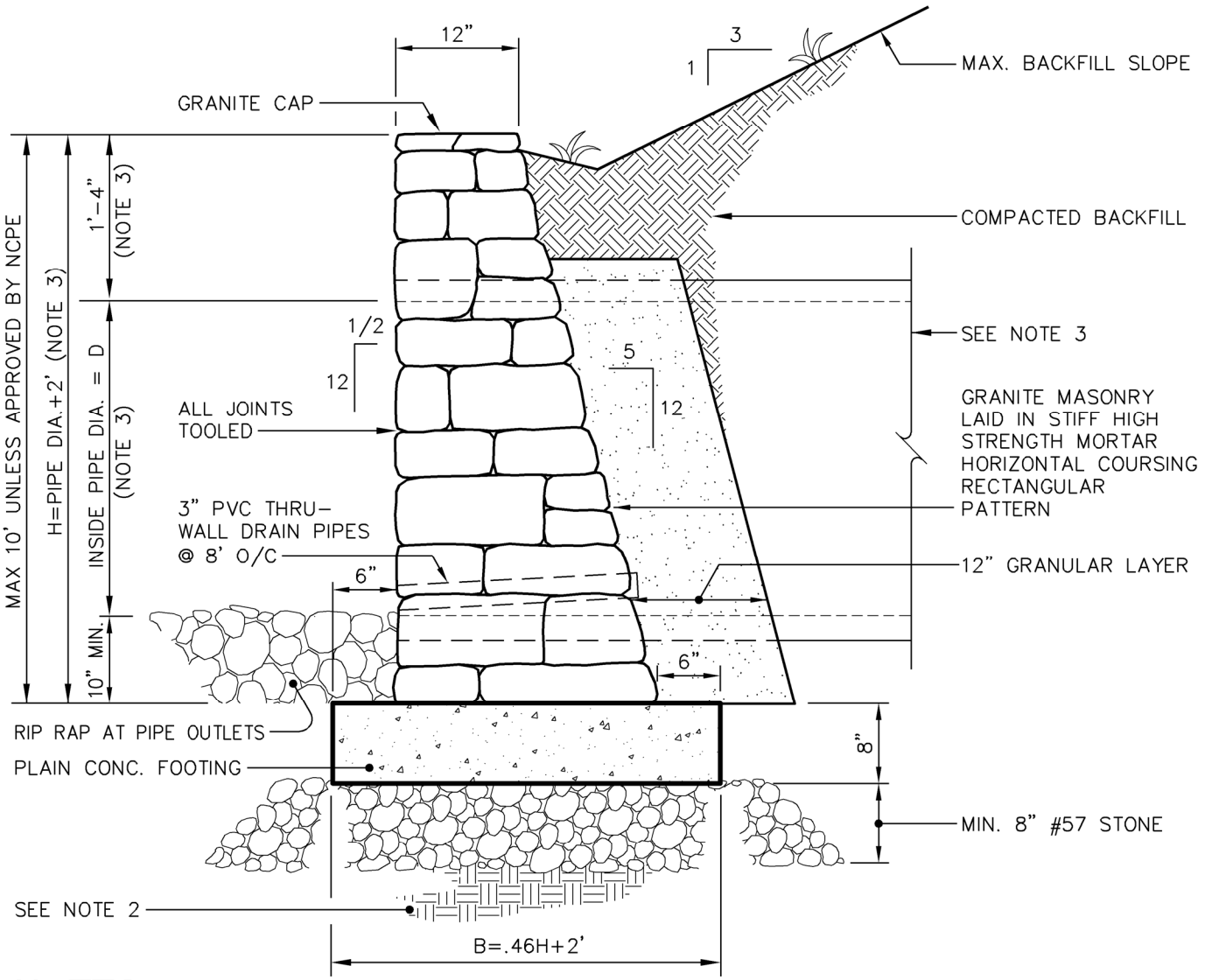
OPTIONAL MORTAR KEY

1. Embedment of the first course of black in a poured footing may be omitted by providing a mortar key. The key is formed by embedding a flat 2" x 4" flush with the top of the freshly poured footing. Remove the 2" x 4" after the concrete has started to harden.

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL MASONRY RETAINING WALL

SCALE:	DETAIL #
Not To Scale	2408.02
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NOTES:

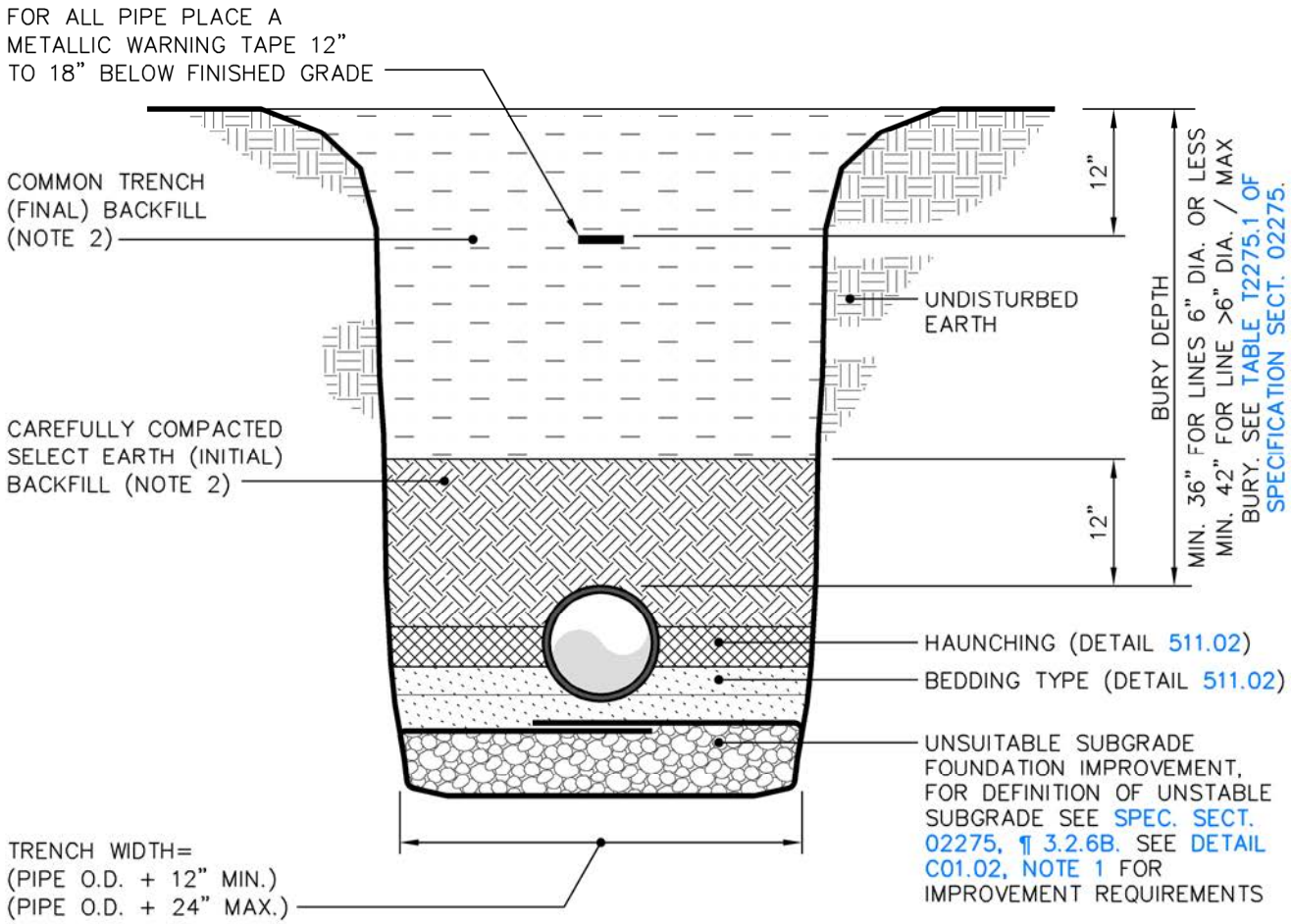
1. Through-wall drain pipes are to be one continuous length.
2. Compression of subgrade at toe to be verified by NCPE to determine that subgrade soil pressure is adequate for loading conditions. If compression at toe exceeds the safe bearing capacity of the soil, footing subgrade improvement will be necessary. Consult with Engineer for guidance.
3. Wall may be used for pipe head/endwall.
4. Solid clay brick or solid concrete masonry may be used in lieu of granite.
5. Concrete footing to be minimum 3000 psi concrete.
6. Design Assumptions:
   A. Base = 0.46 H
   B. Weight of soil behind wall = 110 pcf
   C. Angle of Repose = 1 1/2:1
   D. Wall to be battered a minimum of 1/2:12.
   E. Granular backfill to be #57 stone or sand.
   F. No surcharge behind the wall was considered.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL GRANITE GRAVITY RETAINING WALL

SCALE:	DETAIL #
Not To Scale	2408.03
REVISION DATE: December, 2022	SHEET #: 1 of 1



NOTES:

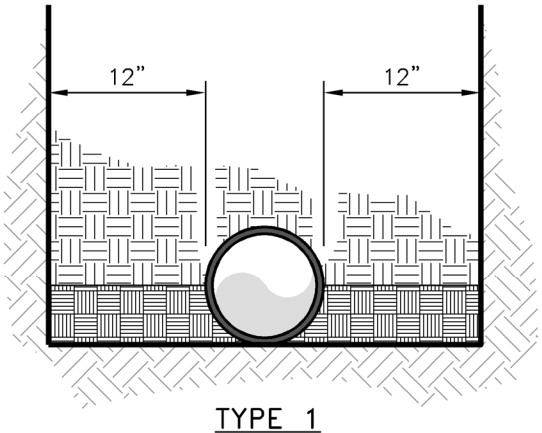
1. See specifications Section 02275, Part 2 – Products for composition of Select Earth Backfill and Common Trench Backfill.
2. See detail C01.04 for marker ball placement / locations.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

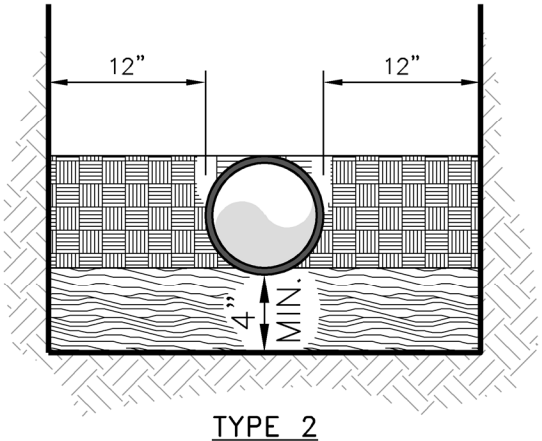
WATER MAIN PIPE LAYING CONDITIONS

SCALE:	DETAIL #
Not To Scale	2 511.01
REVISION DATE: April, 2024	SHEET #: 1 of 1



TYPE 1

FLAT BOTTOM TRENCH WITH BACKFILL LIGHTLY CONSOLIDATED TO CENTERLINE OF PIPE (FLAT BOTTOM IS DEFINED AS UNDISTURBED EARTH)



TYPE 2

PIPE BEDDED IN 4" MINIMUM SAND OR LOOSE SOIL (NOTE 5) TO A DEPTH OF 1/8 PIPE DIA. WITH BACKFILL COMPACTED TO TOP OF PIPE

NOTES:

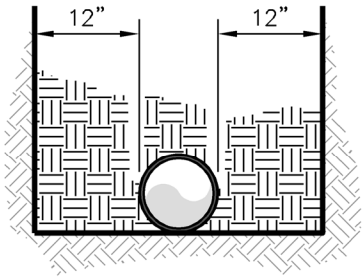
1. For normal pipe sizes 14 inch and larger, consideration should be given to the use of laying conditions other than Type 1.
2. Consideration of the pipe–zone embedment conditions included in this figure may be influenced by factors other than pipe strength. For additional information on pipe bedding and backfill, see ANSI/AWWA C600.
3. See detail 511.01 for unsuitable trench subgrade requirements.
4. See Specifications Section 02275, Section 2.1.2 for pipe bedding definitions.
5. Loose soil shall be either native soil excavated from trench or borrow, both conforming in composition to "Select Earth Backfill" as defined in Specifications Section 02275, Part 2 – PRODUCTS.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

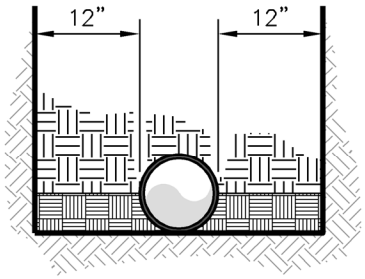
WATER MAIN EMBEDMENT DETAILS

SCALE:	DETAIL #
Not To Scale	511.02
REVISION DATE:	SHEET #:
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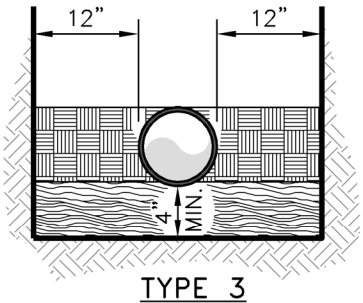
TYPE 1

(NOTE 1)
FLAT BOTTOM TRENCH WITH LOOSE DIRT
(FLAT BOTTOM IS DEFINED AS
UNDISTURBED EARTH)



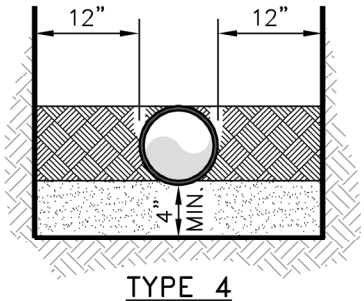
TYPE 2

FLAT BOTTOM TRENCH WITH BACKFILL LIGHTLY
CONSOLIDATED TO CENTERLINE OF PIPE
(FLAT BOTTOM IS DEFINED AS UNDISTURBED
EARTH)



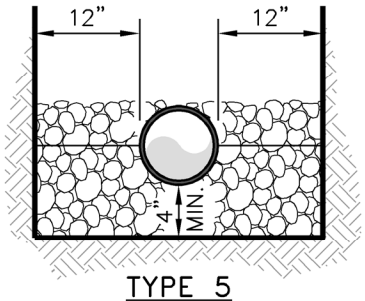
TYPE 3

PIPE BEDDED IN 4" MINIMUM LOOSE SOIL WITH BACKFILL
LIGHTLY CONSOLIDATED TO TOP OF PIPE
(LOOSE SOIL IS DEFINED AS NATIVE SOIL EXCAVATED
FROM THE TRENCH, FREE OF ROCKS, ORGANIC MATERIAL,
FOREIGN MATERIALS AND FROZEN EARTH)



TYPE 4

PIPE BEDDED IN SAND, GRAVEL, or
CRUSHED STONE TO A DEPTH OF 1/8 PIPE
DIAMETER, 4" MINIMUM. WITH BACKFILL
COMPACTED TO TOP OF PIPE.
(APPROXIMATELY 80 PERCENT STANDARD
PROCTOR, AASHTO T-99)



TYPE 5

PIPE BEDDED TO IT'S CENTERLINE IN COMPACTED GRANULAR
MATERIAL,CRUSHED STONE, (SAND OR STONE SCREENINGS),
4" MINIMUM UNDER PIPE. COMPACTED GRANULAR OR
SELECT MATERIAL TO TOP OF PIPE. (APPROXIMATELY 90
PERCENT STANDARD PROCTOR, AASHTO T-99) (SELECT
MATERIAL IS DEFINED AS NATIVE SOIL EXCAVATED FROM
THE TRENCH, FREE OF ROCKS, ORGANIC MATERIAL, FOREIGN
MATERIALS AND FROZEN EARTH)

NOTES:

1. For normal water pipe sizes 14 inch and larger, consideration should be given to the use of laying conditions other than Type 1.
2. Consideration of the pipe-zone embedment conditions included in this figure may be influenced by factors other than pipe strength. For additional information on pipe bedding and backfill, see ANSI/AWWA C600.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PIPE EMBEDMENT DETAILS

SCALE:	DETAIL #
Not To Scale	2 511.02
REVISION DATE: Oct., 2022	SHEET #: 2 of 4

Details Provided by APPIAN Consulting Engineers – www.appianengineers.com
11/06/2024 – 11:38:02 AM

TABLE 10.7 – DESCRIPTION OF MATERIAL CLASSIFICATION (As Defined in ASTM 2321)

Class	Type	Soil Symbol Group	Description ASTM D 2487	Percentage Passing Sieve Sizes			Atterbreg Limits		Coefficients	
				1.5 in (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PL	Uniformity Cu	Curvature Cc
IA	Manufactured Aggregates: open graded, clean	None	Angular, crushed stone or rock, crushed gravel, broken coral, crushed slag, cinders or shells: large void content, contain little or no fines	100	≤10%	<5	Non Plastic			
IB	Manufactured, Processed Aggregates: dense graded, clean	None	Angular, crushed stone (or other Class IA materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils: contain little or no fines	100	≤50%	<5	Non Plastic			
II	Coarse–Grained Soils, clean	GW	Well–graded gravels and gravel–sand mixtures; little or no fines	100	<50% of Coarse Fraction	<5	Non Plastic		>4	1 to 3
		GP	Poorly–graded gravels and gravel–sand mixtures; little or no fines						<4	<1 or >3
		SW	Well–graded sands and gravelly sands; little or no fines		>50% of Coarse Fraction				>6	1 to 3
		SP	Poorly–graded sands and gravelly sands; little or no fines						<6	<1 or >3
	Coarse–Grained Soils, borderline clean to w/fines	e.g. GW–GC, SP–SM	Sands and gravels which cre borderline between clean and with fines	100	Varies	5% to 12%	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse–Grained Soils with Fines	GM	Silty gravels, gravel–sand–silt mixtures	100	>50% of Coarse Fraction	>12% to <50%		<4 or <"A" Line		
		GC	Clayey gravels, gravel–sand–clay mixtures					<7 or >"A" Line		
		SM	Silty sands, sand–silt mixtures		>50% of Coarse Fraction			>4 or <"A" Line		
		SC	Clayey sands, sand–silt mixtures					>7 or >"A" Line		
IV	Fine–Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity	100	100	>50	<50	<4 or <"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays					>7 or >"A" Line		
IVB	Fine–Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	100	100	>50	>50	<"A" Line		
		CH	Inorganic clays of high plasticity, fat clays					>"A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity	100	100	>50	<50	<4 or <"A" Line		
		OH	Organic clays of medium to high plasticity, organic silts				>50	<"A" Line		
	Highly Organic	PT	Peat and other high organic soils							

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PIPE EMBEDMENT DETAILS

SCALE: Not To Scale

REVISION DATE: Oct., 2022

DETAIL # 2.511.02

SHEET #: 3 of 4

TABLE 10.8
RECOMMENDATIONS FOR INSTALLATION AND USE OF SOILS
AND AGGREGATES FOR FOUNDATION, EMBEDMENT AND BACKFILL

	Soil Class (see Table 10.7)A				
	CLASS IA	CLASS IB	CLASS II	CLASS III	CLASS IV-A
General Recommendations and Restrictions	Do not use where conditions may cause migration of fines from adjacent soil and loss of pipe support. Suitable for use as a drainage blanket and underdrain in rock cuts where adjacent material is suitably graded.	Process materials as required to obtain gradation which will minimize migration of adjacent materials. Suitable for use as drainage blanket and underdrain.	Where hydraulic gradient exists check gradation to minimize migration. "Clean" groups suitable for use as drainage blanket and underdrain.	Do not use where water conditions in trench may cause instability.	Obtain geotechnical evaluation of proposed material. May not be suitable under high earth fills, surface applied wheel loads and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6-in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6-in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6-in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Do not use in thickness greater than 12 in. total. Install and compact in 6-in. maximum layers.	Suitable only in undisturbed condition and where trench is dry. Remove all loose material and provide firm, uniform trench bottom before bedding is placed.
Bedding	Suitable as restricted above. Install in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable as restricted above. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).
Haunching	Suitable as restricted above. Install in 6-in. maximum layers. Work in around pipe by hand to provide uniform support.	Install and compact in 6-in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6-in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact 6-in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6-in. maximum layers. Work in around pipe by hand to provide uniform support.
Initial Backfill	Suitable as restricted above. Install to a minimum of 6 in. above pipe crown.	Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.
Final Backfill	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Suitable as restricted above. Compact as required by the engineer.

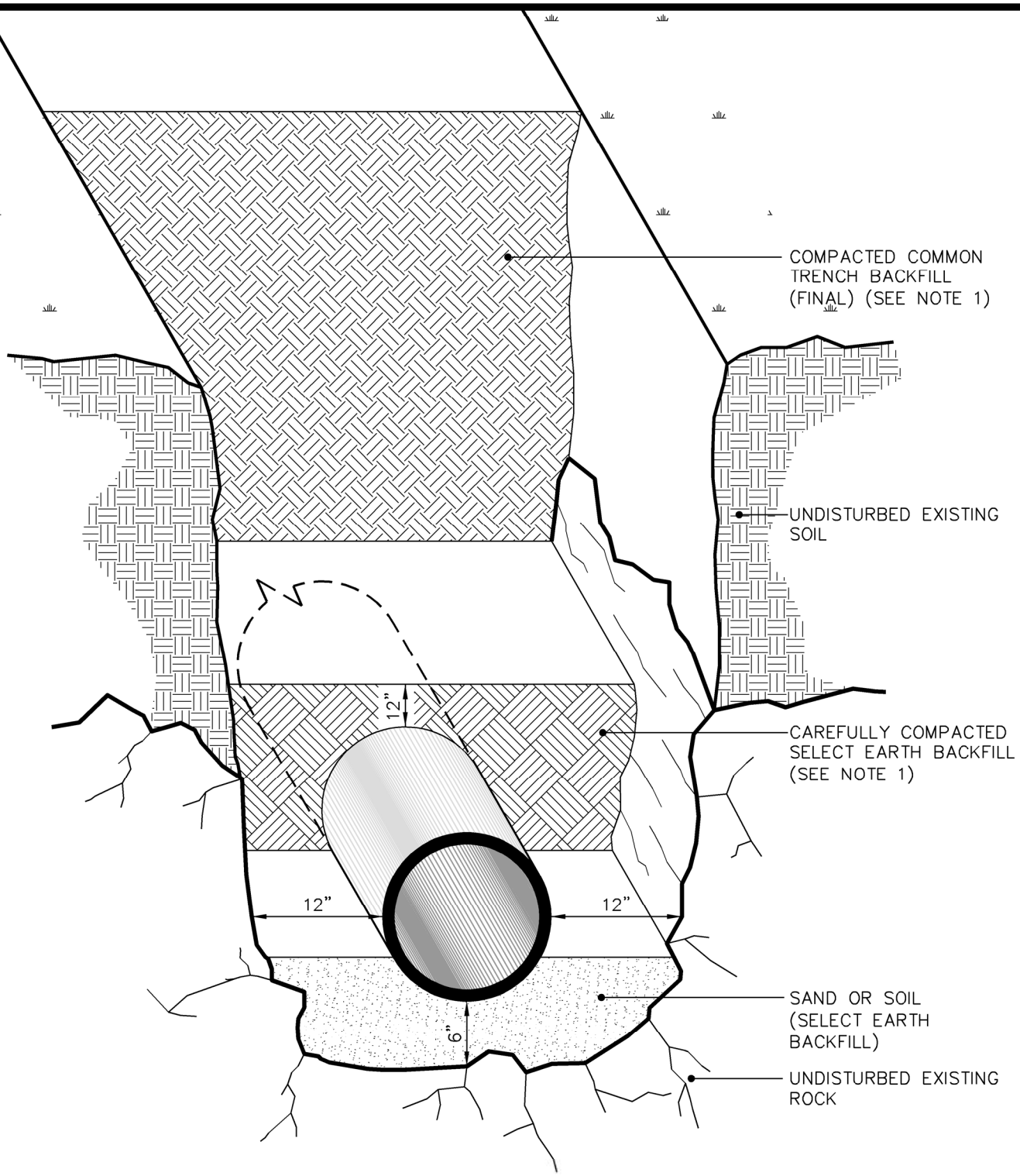
NORTH CAROLINA CLAYTON 1869

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PIPE EMBEDMENT DETAILS

SCALE:	DETAIL #
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NOTES:

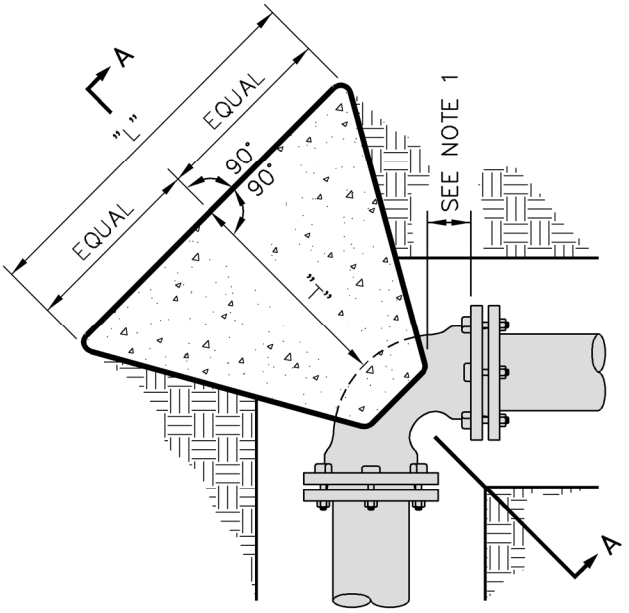
1. See specification section 02275 Trenching, Backfilling, and Compaction of Utilities for backfill and compaction requirements.

TOWN of CLAYTON

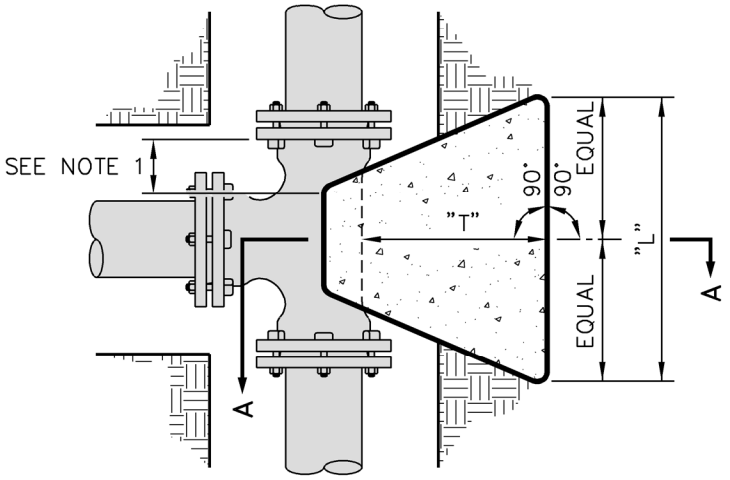
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

DETAIL of ROCK EXCAVATION

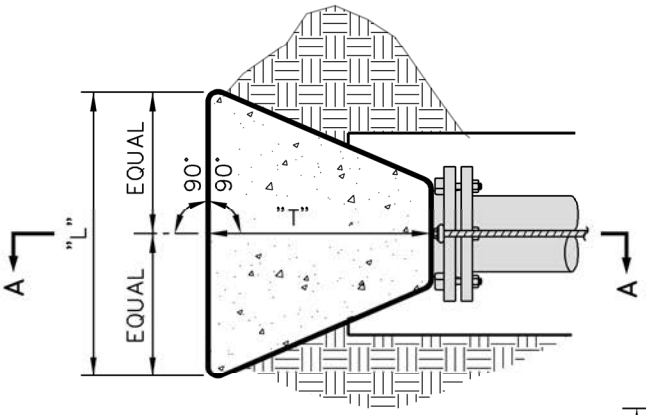
SCALE:	DETAIL #
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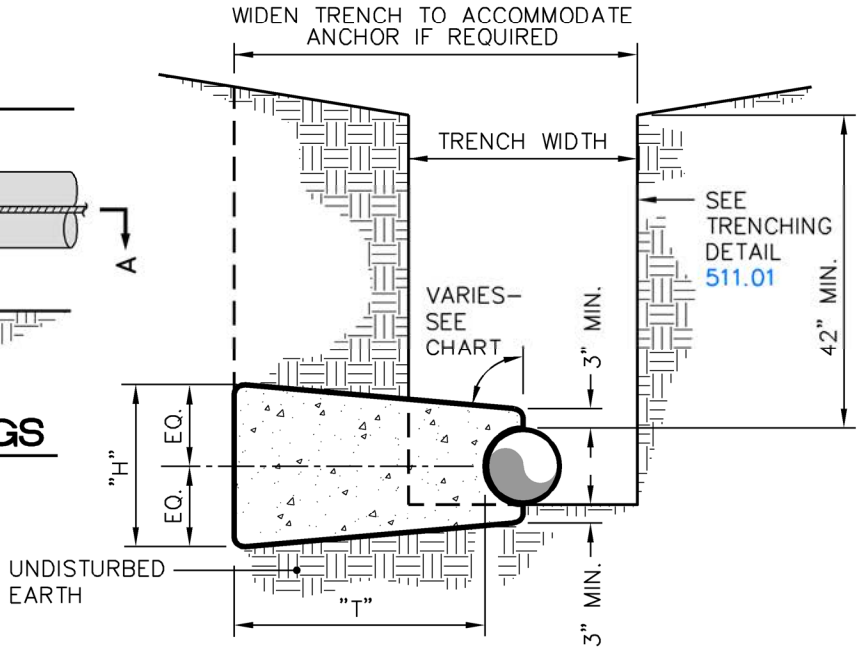
FOR ALL BEND FITTINGS



FOR TEE FITTING



FOR ALL PLUG FITTINGS



SECTION A-A

NOTES:

1. Concrete blocking is to be formed to ensure accessibility to fittings and poured against undisturbed earth.
2. Fittings are to be completely wrapped with minimum 6 mil. polyethylene plastic, prior to pouring concrete.
3. Concrete to be minimum 3,000 psi. @ 28 days.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

HORIZONTAL BLOCKING DETAIL for BENDS, TEE, & PLUG

SCALE:	DETAIL #
Not To Scale	2512-01
REVISION DATE:	SHEET #:
Oct., 2022	1 of 2

TEST PRESSURE = 150 P.S.I.

PIPE SIZE	TYPE FITTING	DIMENSIONS (Ft.) "L"	"H"	"T"	VOLUME. CONCRETE CU. YD.
<4 INCHES	11 1/4°	---	---	---	---
	22 1/2°	1.00	1.00	1.50	0.06
	45°	1.00	1.00	1.50	0.06
	90°	1.00	1.00	2.50	0.09
	TEE / PLUG	1.00	1.00	2.00	0.07
4 INCHES	11 1/4°	1.00	1.00	2.50	0.09
	22 1/2°	1.00	1.00	2.50	0.09
	45°	1.00	1.00	2.50	0.09
	90°	1.50	1.50	2.50	0.15
	TEE / PLUG	1.50	1.50	2.00	0.12
6 INCHES	11 1/4°	1.50	1.50	2.50	0.15
	22 1/2°	1.50	1.50	2.50	0.15
	45°	1.50	1.50	2.50	0.15
	90°	2.00	2.00	3.00	0.28
	TEE / PLUG	2.00	2.00	2.50	0.23
8 INCHES	11 1/4°	2.00	2.00	2.50	0.23
	22 1/2°	2.00	2.00	2.50	0.23
	45°	2.00	2.00	2.75	0.25
	90°	3.00	2.00	3.00	0.39
	TEE / PLUG	3.00	2.00	2.50	0.32
12 INCHES	11 1/4°	2.00	2.00	3.00	0.28
	22 1/2°	2.00	2.00	3.00	0.28
	45°	3.00	2.50	3.00	0.47
	90°	4.50	3.00	3.50	0.94
	TEE / PLUG	4.50	3.00	3.00	0.81
16 INCHES	11 1/4°	2.00	2.00	3.00	0.28
	22 1/2°	3.00	2.00	3.00	0.39
	45°	4.00	3.00	3.50	0.84
	90°	6.50	3.50	3.50	1.54
	TEE / PLUG	6.50	3.50	3.00	1.32

TEST PRESSURE = 200 P.S.I.

PIPE SIZE	TYPE FITTING	DIMENSIONS (Ft.) "L"	"H"	"T"	VOLUME. CONCRETE CU. YD.
<4 INCHES	11 1/4°	1.00	1.00	1.00	0.04
	22 1/2°	1.00	1.00	1.50	0.06
	45°	1.00	1.00	1.50	0.06
	90°	1.50	1.50	2.50	0.15
	TEE	1.50	1.50	2.00	0.12
4 INCHES	11 1/4°	1.00	1.00	2.50	0.09
	22 1/2°	1.00	1.00	2.50	0.09
	45°	1.50	1.50	2.50	0.15
	90°	1.50	1.50	2.50	0.15
	TEE	1.50	1.50	2.00	0.12
6 INCHES	11 1/4°	1.50	1.50	2.50	0.15
	22 1/2°	1.50	1.50	2.50	0.15
	45°	1.50	1.50	2.50	0.15
	90°	2.50	2.00	3.00	0.33
	TEE	2.50	2.00	2.50	0.28
8 INCHES	11 1/4°	2.00	2.00	2.50	0.23
	22 1/2°	2.00	2.00	2.50	0.23
	45°	2.00	2.00	2.50	0.23
	90°	4.00	2.00	3.00	0.50
	TEE	4.00	2.00	2.50	0.42
12 INCHES	11 1/4°	2.00	2.00	3.00	0.28
	22 1/2°	3.00	2.00	3.00	0.39
	45°	4.00	2.50	3.00	0.61
	90°	5.50	3.00	3.50	1.13
	TEE	5.50	3.00	3.00	0.97
16 INCHES	11 1/4°	2.00	2.00	3.00	0.28
	22 1/2°	4.00	2.00	3.00	0.50
	45°	5.50	3.00	3.50	1.13
	90°	7.50	4.00	3.50	2.01
	TEE	7.50	4.00	3.00	1.72

CHART NOTES:

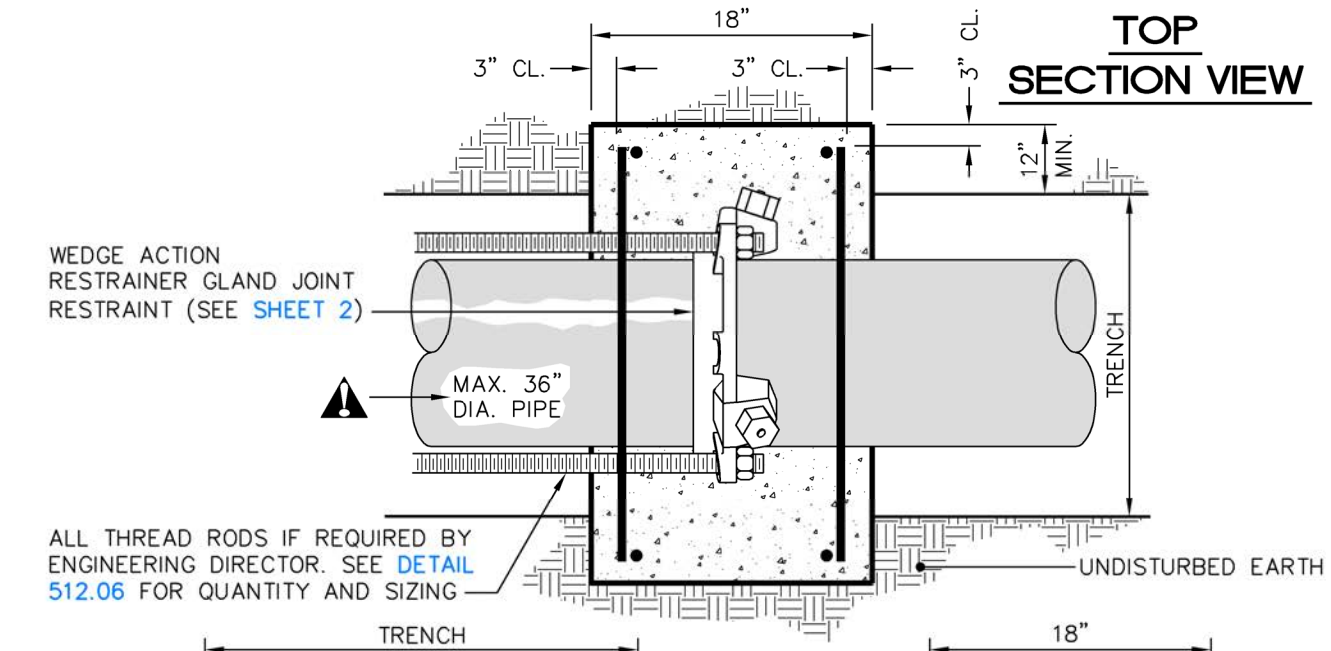
1. If blocking excavation is in lightly compacted fill areas, or in areas where boulders or stumps have been removed, blocking size must be re-sized for the specific location/circumstance by a NC licensed Professional Engineer.
2. Blocking sizes shown in these tables assume the following:
   A. Blocking is constructed in residual soils as shown in detail.
   B. Soil bearing pressure = 2000 psf
   C. Velocity of flow = 15 fps.
3. This detail not applicable to reducing bends.
4. Neither the weight of the concrete blocking nor friction between concrete blocking and soil was added into blocking sizes computation; increasing the design safety factor.

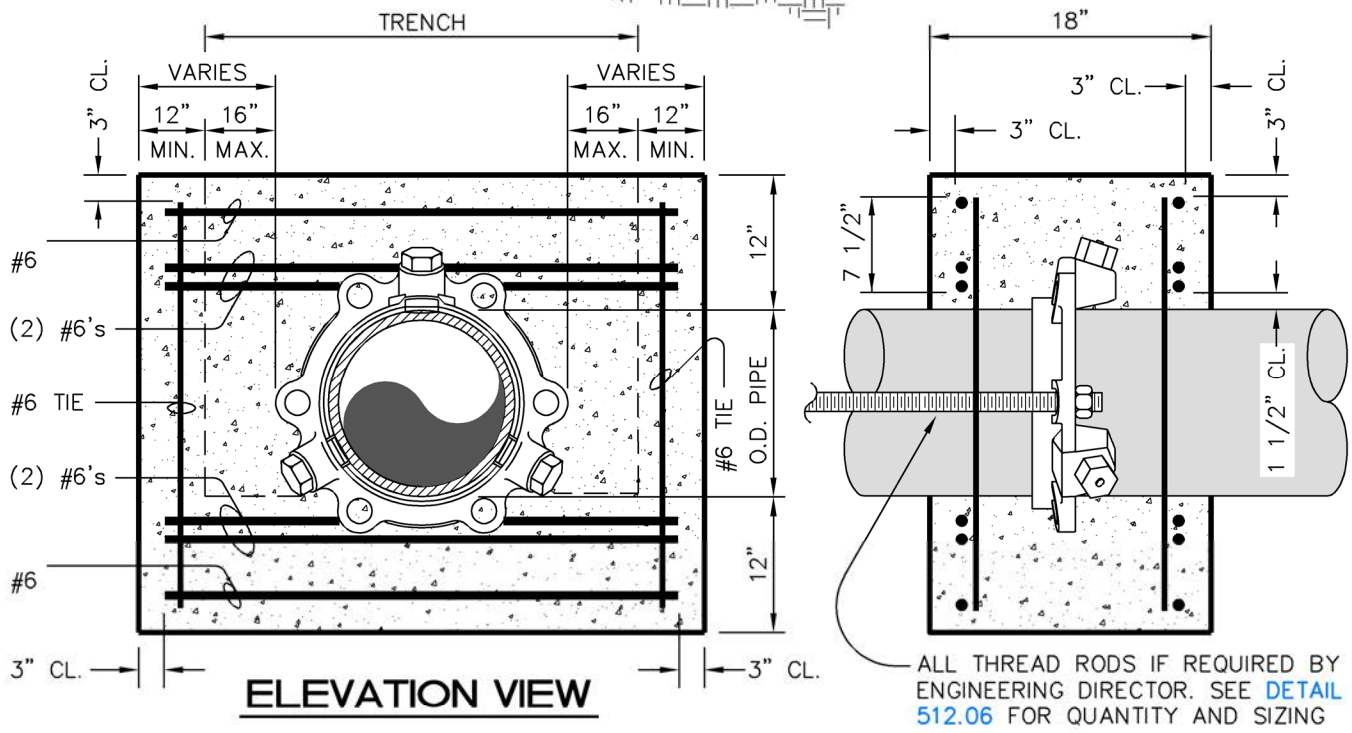
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

HORIZONTAL BLOCKING DETAIL for BENDS, TEE, & PLUG

SCALE:	DETAIL #
Not To Scale	2 512-01
REVISION DATE: Oct., 2022	SHEET #: 2 of 2





NOTES:

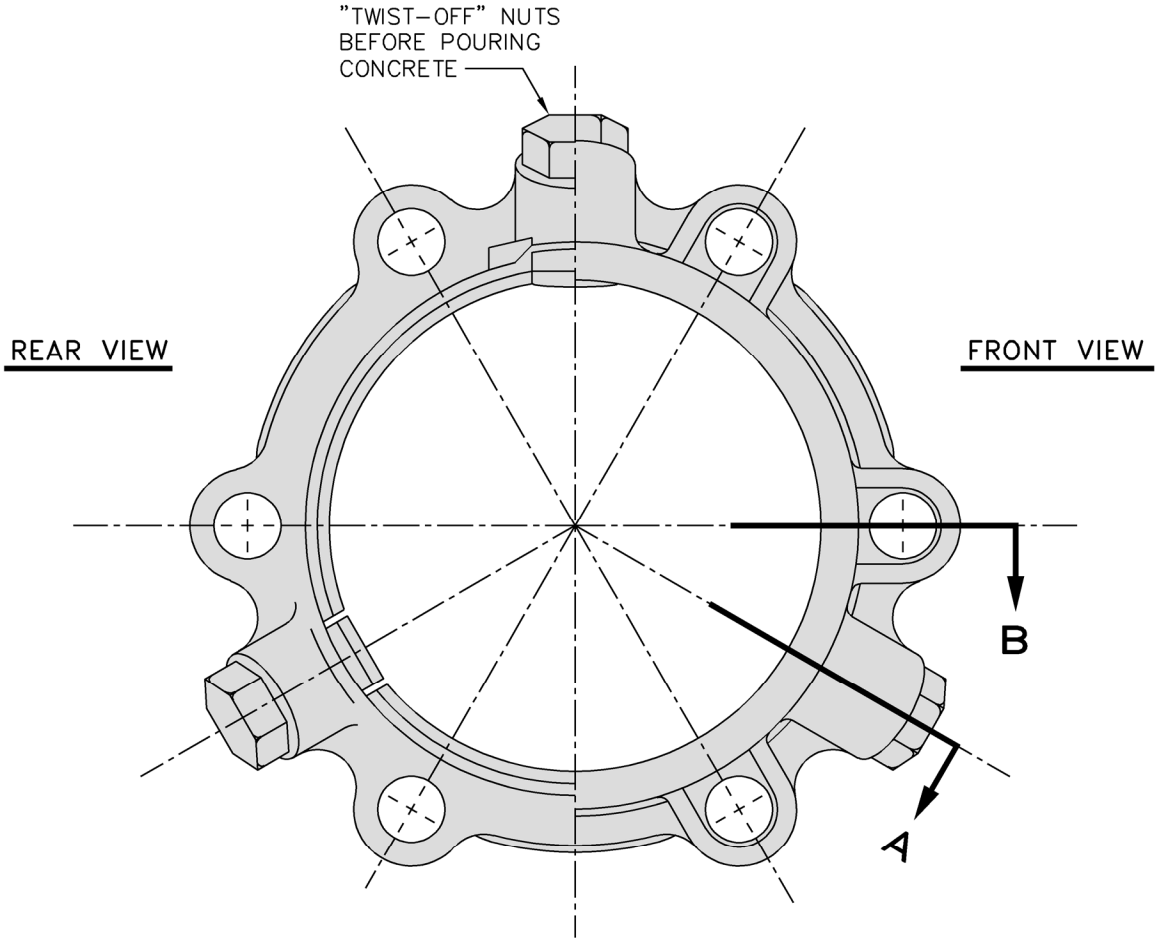
1. Concrete shall 3000 P.S.I.
2. Reinforcing bars shall be deformed bars, and tied together.
3. Trench bottom width in vicinity of thrust block(s) installation shall be the minimum width for placement of pipe (Max trench width = pipe O.D.+2 Ft.)
4. Backfill and compact in 6" layers.
5. Place thrust collar on one full joint of pipe.
6. Last joint of pipe with thrust collar to be mechanical joint pipe.
7. Place wedge action restrainer gland joint restraint 4 feet from plug end of pipe.

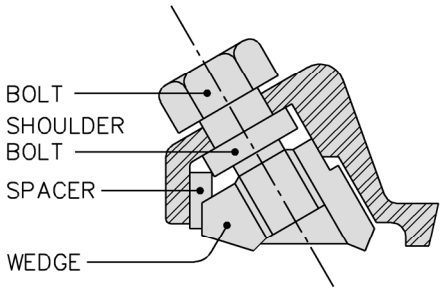
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

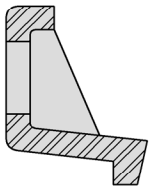
THRUST COLLAR & BLOCKING with WEDGE ACTION RESTRAINER GLAND

SCALE:	DETAIL #
Not To Scale	512.02
REVISION DATE: Oct., 2022	SHEET #: 1 of 2





SECTION A



SECTION B

NOTES:

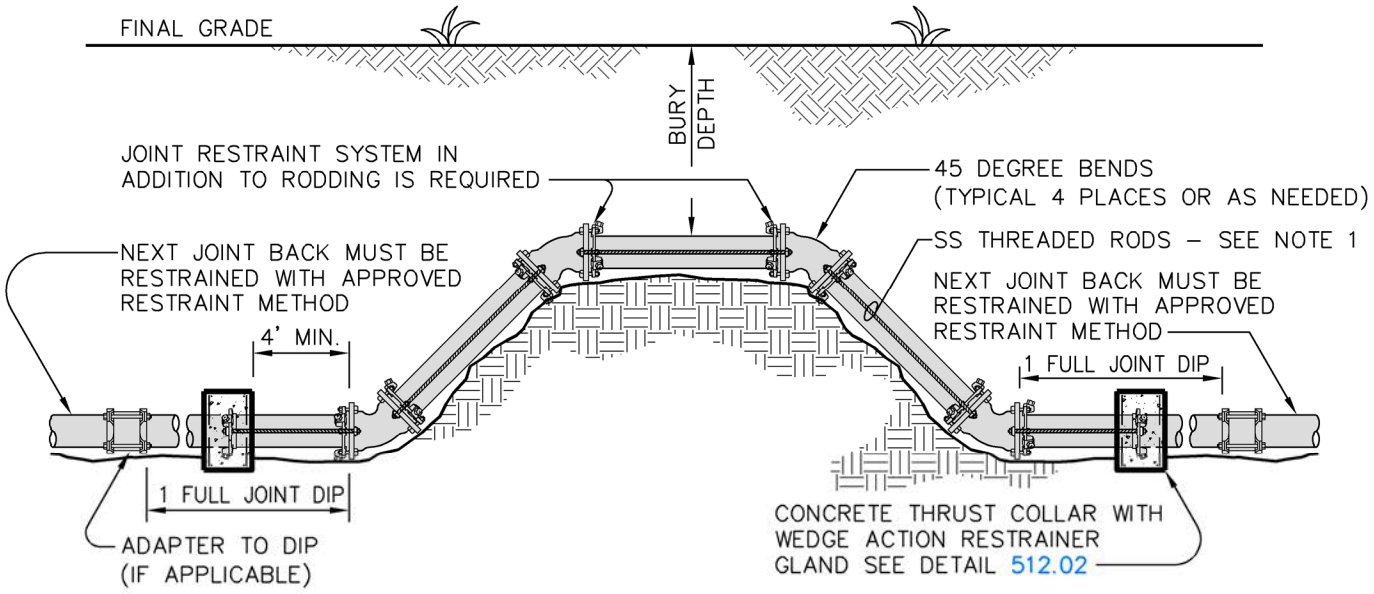
1. Refer to Pre–Approved product list for approved manufacturer and model numbers.
2. Gland to come with 3/4" x 3 1/2" 316 stainless steel T–bolts w/ nuts.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

WEDGE ACTION RESTRAINER JOINT / GLAND DETAIL

SCALE:	DETAIL #
Not To Scale	2512.02
REVISION DATE:	SHEET #:
Oct., 2022	2 of 2

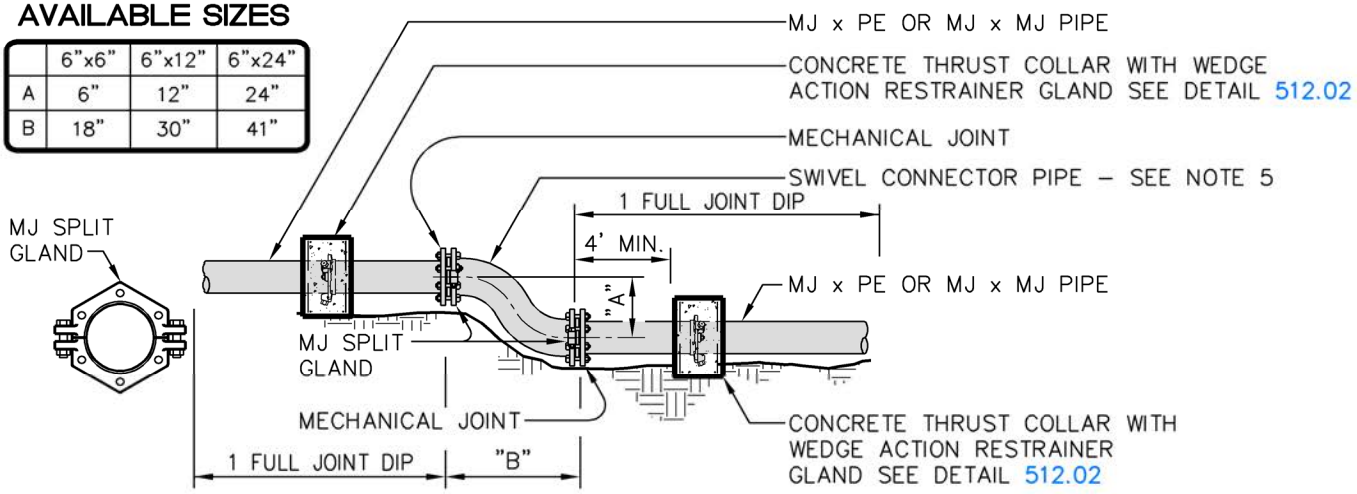


ALTERNATE SWIVEL CONNECTOR

(6" WATER LINE)

AVAILABLE SIZES

	6"x6"	6"x12"	6"x24"
A	6"	12"	24"
B	18"	30"	41"



NOTES:

1. See Tie Rod Anchors Datum Chart, detail 512.06 for quantity & sizing of ss rodding.
2. The bypass is to be assembled above ground first.
3. Record all as-built lengths using the center lines of the pipes or bends as reference points.
4. Adapters vary in type according to the material of the existing water main.
5. Compact ductile iron (350 p.s.i.) fire hydrant offset connector pipe (AWWA C-110-ANSI A21.4) equal to or exceeding "GRADE LOK" as manufactured by: Assured Flow Sales, Inc., 1-(800)-388-0678

TOWN of CLAYTON

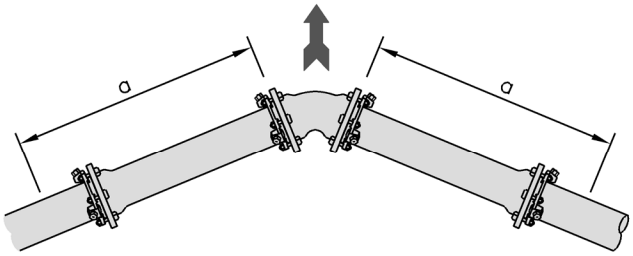
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

VERTICAL BEND, RODDING, and BLOCKING DETAIL

SCALE:	DETAIL #
Not To Scale	512.04
REVISION DATE: Oct., 2022	SHEET #: 1 of 1

Restraint Length Chart (for Fittings)

	Tee							Horizontal Bend				Reducer		Dead End
	a	b (branch)						a				a		a
Nominal Size		4"	6"	8"	12"	16"	24"	11 1/4°	22 1/2°	45°	90°	Smaller Line Size	Restraint Length	Restraint Length
6"	9'	1'	14'	-	-	-	-	2'	4'	7'	17'	4"	19'	36'
8"	9'	1'	7'	9'	-	-	-	3'	5'	9'	22'	6"	20'	47'
12"	9'	1'	1'	12'	43'	-	-	3'	6'	13'	30'	8"	35'	65'
16"	9'	1'	1'	1'	33'	61'	-	4'	8'	16'	39'	12"	36'	84'
24"	9'	1'	1'	1'	13'	41'	94'	6'	11'	23'	55'	16"	64'	118'
	See Note 1											See Note 2		



HORIZONTAL BEND

Table Design Assumptions

Restrained pipe: DIP

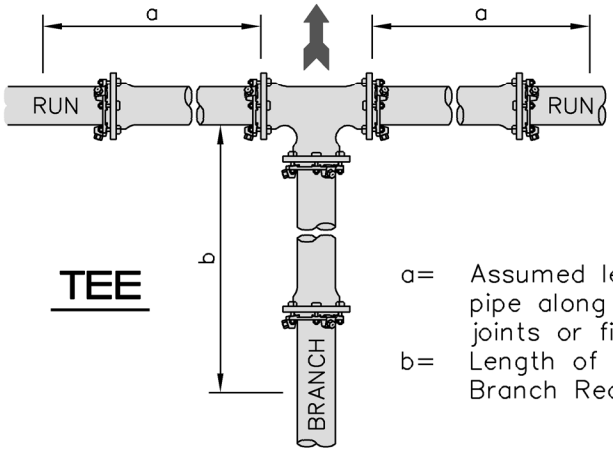
Soil Type: SM, CL (restraint lengths would be less if CL were to be computed)

Safety Factor: 1.5:1 (covers most installations)

Trench Bury: Pipe bedding in 4" of loose soil with backfill lighlty consolidated to top of pipe.

Bury Depth: 3 ft.

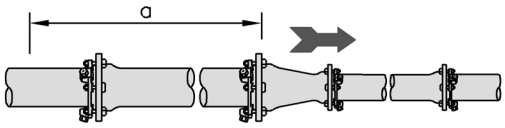
Test Pressure: 150 psi



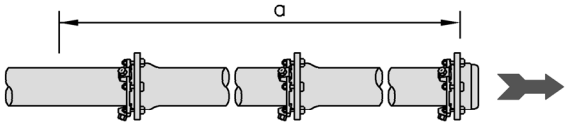
TEE

a= Assumed length of solid pipe along run without joints or fittings.

b= Length of Restrained Branch Required



REDUCER



DEAD END

NOTES:

1. If the length of the solid pipe on either side of the tee or the diameters on any leg of the tee varies, this table does not apply and the restraint length must be calculated.
2. If the diameter of the smaller pipe is anything other than what is shown, restraint length must be calculated.
3. If any of the assumptions vary from what is shown in the table, the restraint length must be calculated.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RESTRAINT LENGTH CHART (FOR FITTINGS)

SCALE: Not To Scale

DETAIL # 2 512.05

REVISION DATE: Oct., 2022

SHEET #: 1 of 1

TIE ROD ANCHORS DATUM

PIPE SIZE (INCHES)	ROD DIAMETER	NUMBER OF SS RODS REQUIRED
TEST PRESSURE = 150 PSI		
6	3/4"	2
8	3/4"	2
10	3/4"	2
12	3/4"	4
16	3/4"	6
20	3/4"	8
24	3/4"	8
30	1"	10
36"	1"	12
TEST PRESSURE = 200 PSI		
6	3/4"	2
8	3/4"	2
10	3/4"	4
12	3/4"	6
16	3/4"	8
20	3/4"	12
24	3/4"	10
30	1"	14
36"	1"	16

316 GRADE STAINLESS STEEL (ALL THREAD) RODS, WASHERS AND NUTS

NOTES:

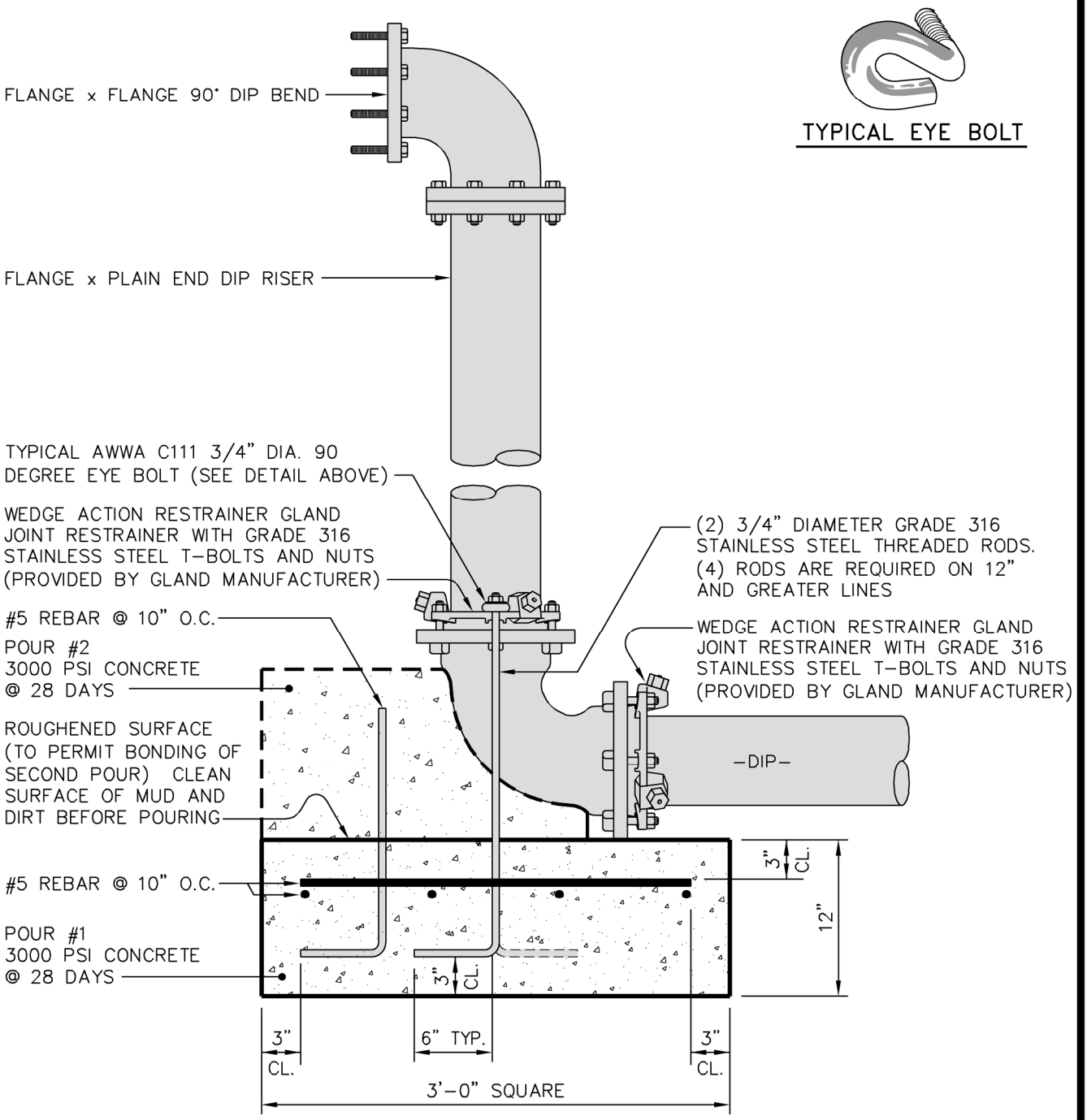
1. See Pre-Approved Products List for ATR, washers & heavy hex nut specifications.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TIE ROD ANCHORS DATUM CHART

SCALE:	DETAIL #
Not To Scale	2512.06
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



TYPICAL EYE BOLT

NOTES:

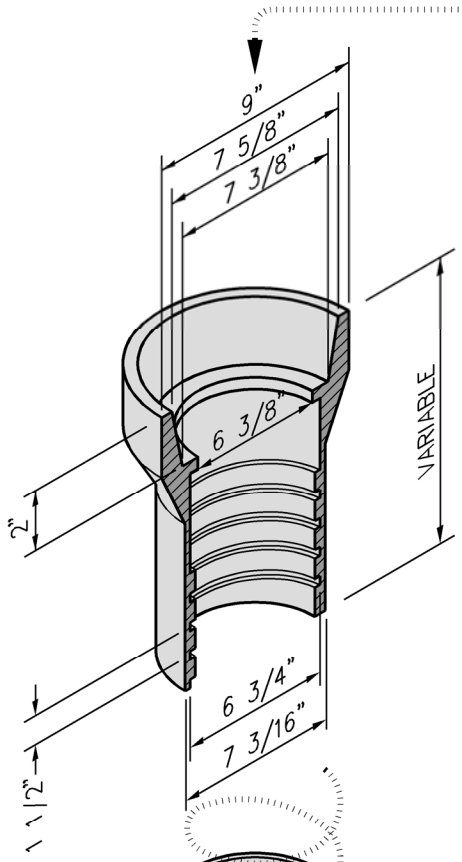
1. Excavate under elbow for footing, place steel & rods in footing & pour (pour #1)
2. Once concrete has set in footing pour horizontal blocking (pour #2)
3. Footing adequate for water mains up to 8". North Carolina licensed Professional Engineer to design footings for lines greater than 8" diameter.

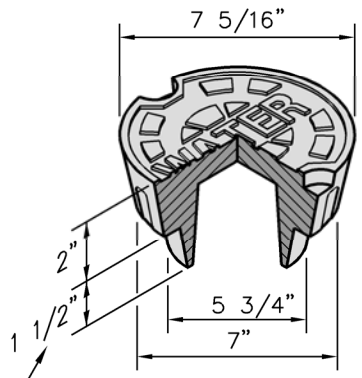
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

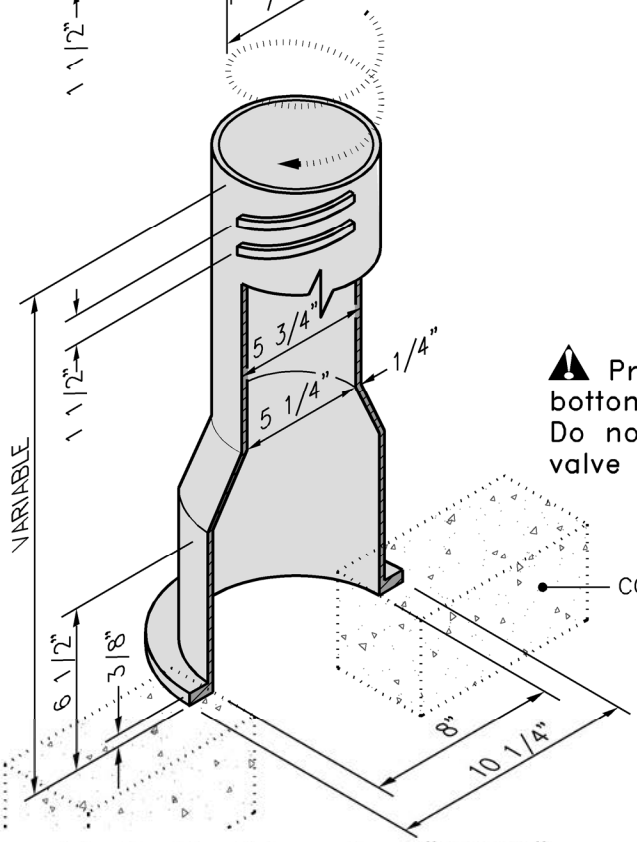
THRUST FOOTING DETAIL

SCALE:	DETAIL #
Not To Scale	2 512.08
REVISION DATE: Oct., 2022	SHEET #: 1 of 1





NOTE:
MAX SIZE COLLAR IS 1 1/2"
SO THAT LID CAN BE REMOVED



⚠ Provide 1" earth cushion between bottom of concrete brick and valve. Do not let valve box or brick rest on valve assembly. – Typical all valves.

NOTES:

1. Use heavy duty traffic lid marked "WATER".
2. Refer to Pre-Approved product list for manufacturer and model numbers.

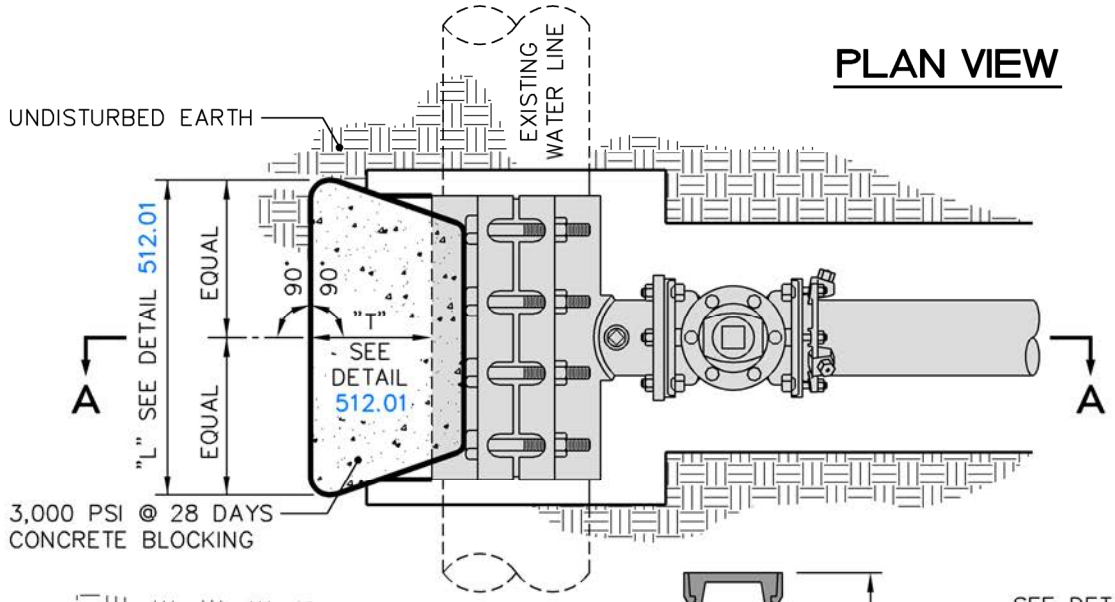
TOWN of CLAYTON

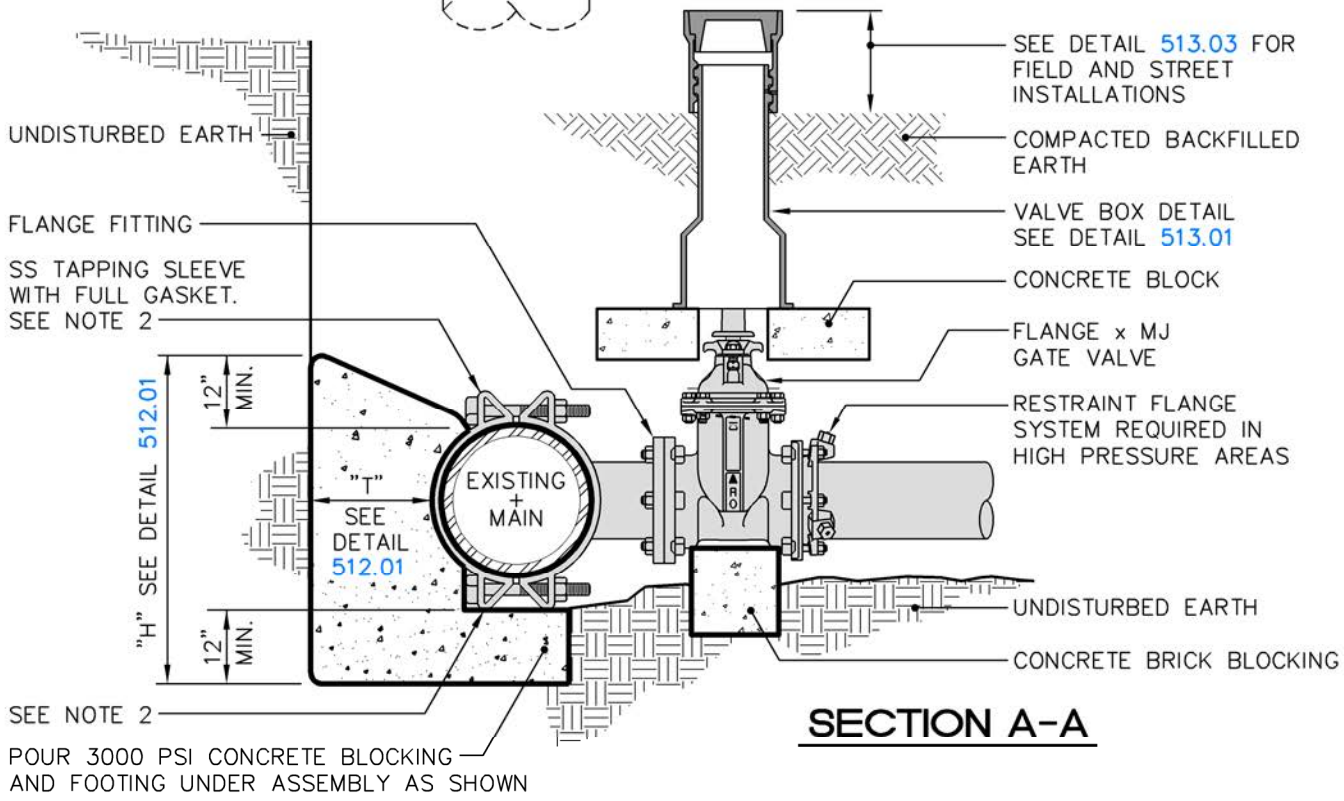
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD HEAVY DUTY SCREW VALVE BOX DETAIL

SCALE:	DETAIL #
Not To Scale	2513.01
REVISION DATE:	SHEET #:
Oct., 2022	1 of 1

PLAN VIEW





SECTION A-A

NOTES:

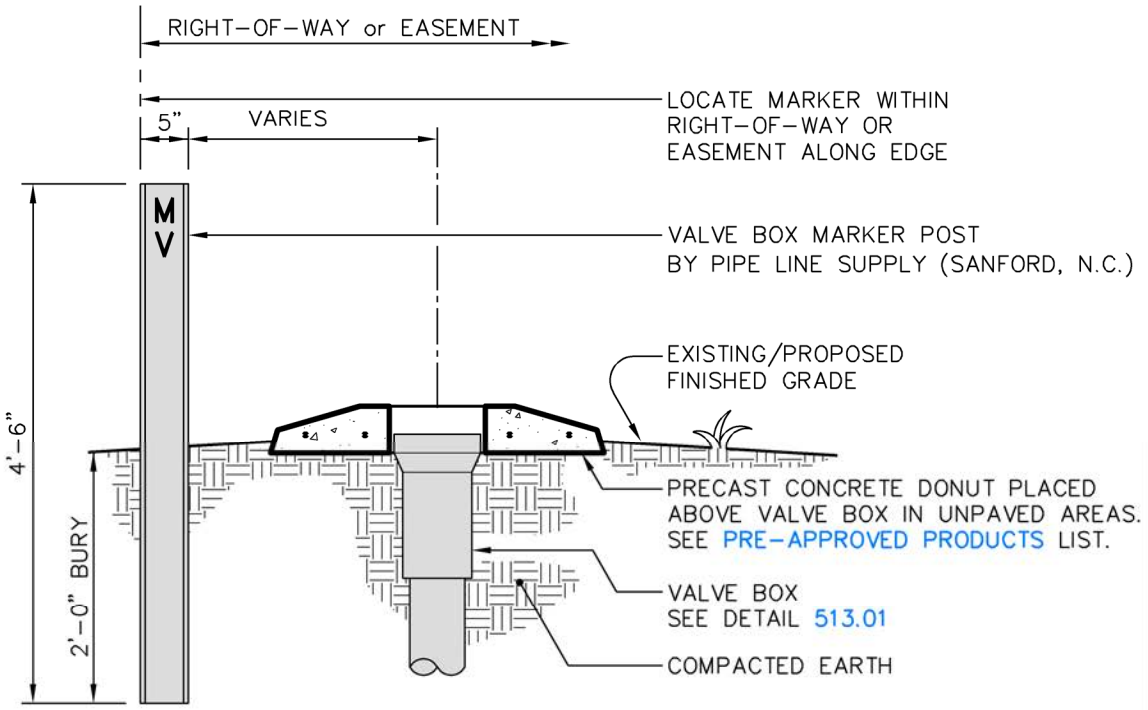
1. Concrete blocking is to be formed to ensure accessibility to fittings and poured against undisturbed earth.
2. Fittings are to be completely wrapped with min. 6 mil. polyethylene plastic, prior to pouring concrete.
3. Concrete to be minimum 3,000 psi. @ 28 days.
4. This detail is only applicable when approved by Engineering Director. Cut–in tee is the required method.

TOWN of CLAYTON

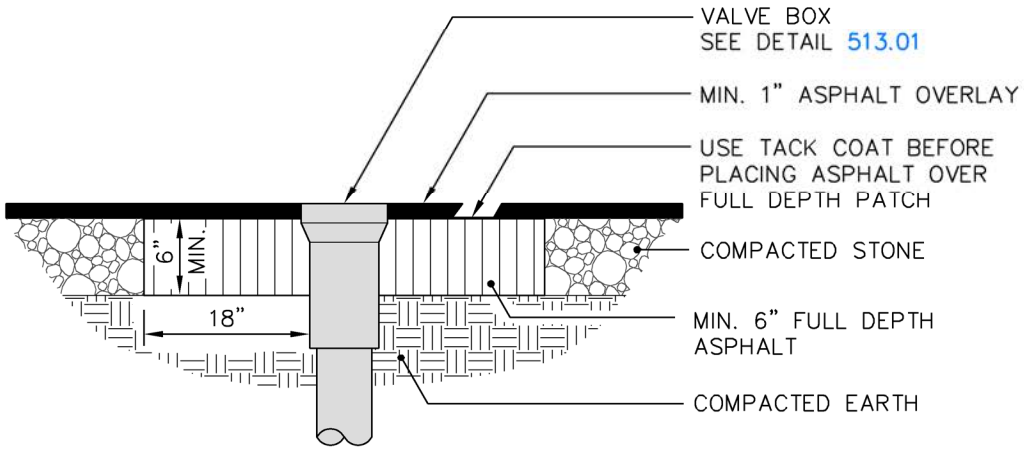
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

4" to 12" STANDARD TAPPING SLEEVE and VALVE ASSEMBLY

SCALE:	DETAIL #
Not To Scale	513.02
REVISION DATE: July, 2023	SHEET #: 1 of 1



FIELD AND EASEMENT OR SIDE OF ROAD LOCATION



IN STREET LOCATION

NOTES:

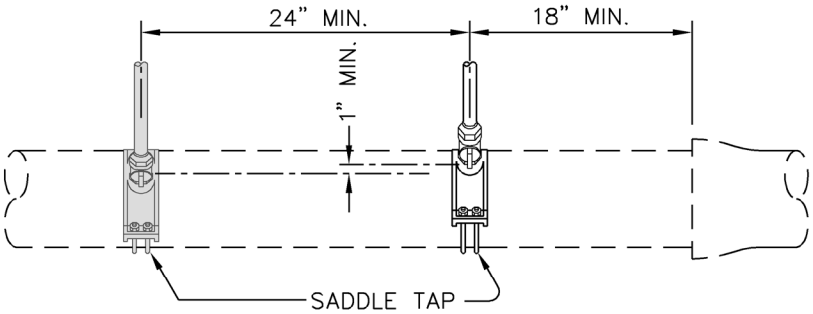
1. Concrete to be minimum 3,000 PSI @ 28 days.

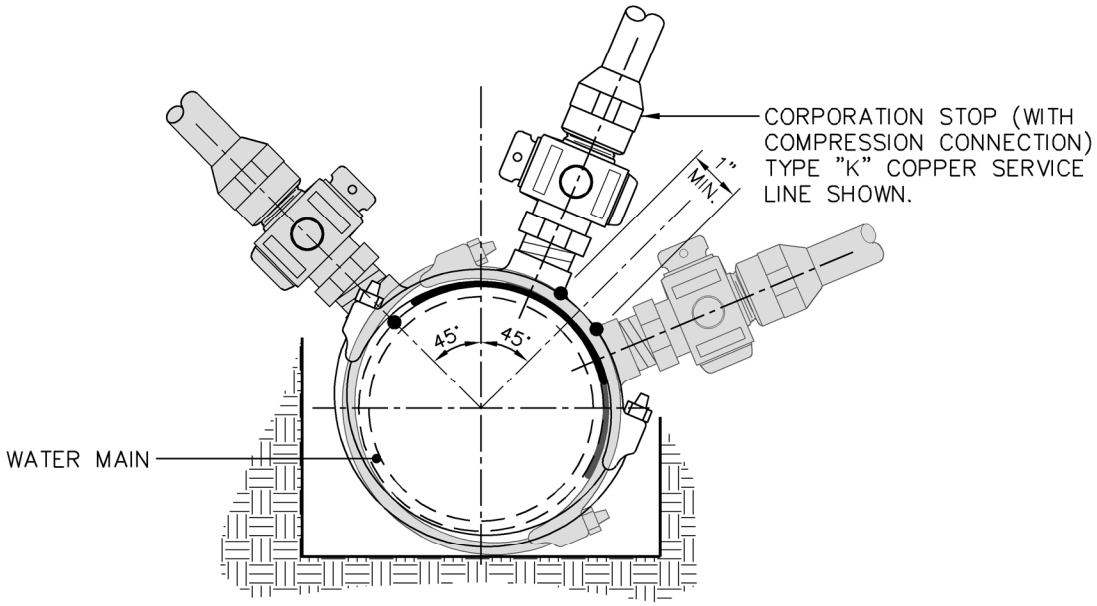
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

VALVE, VALVE BOX, AND MARKER INSTALLATION DETAIL

SCALE:	DETAIL #
Not To Scale	2 513.03
REVISION DATE: Oct., 2022	SHEET #: 1 of 1





SADDLE TAP

NOTES:

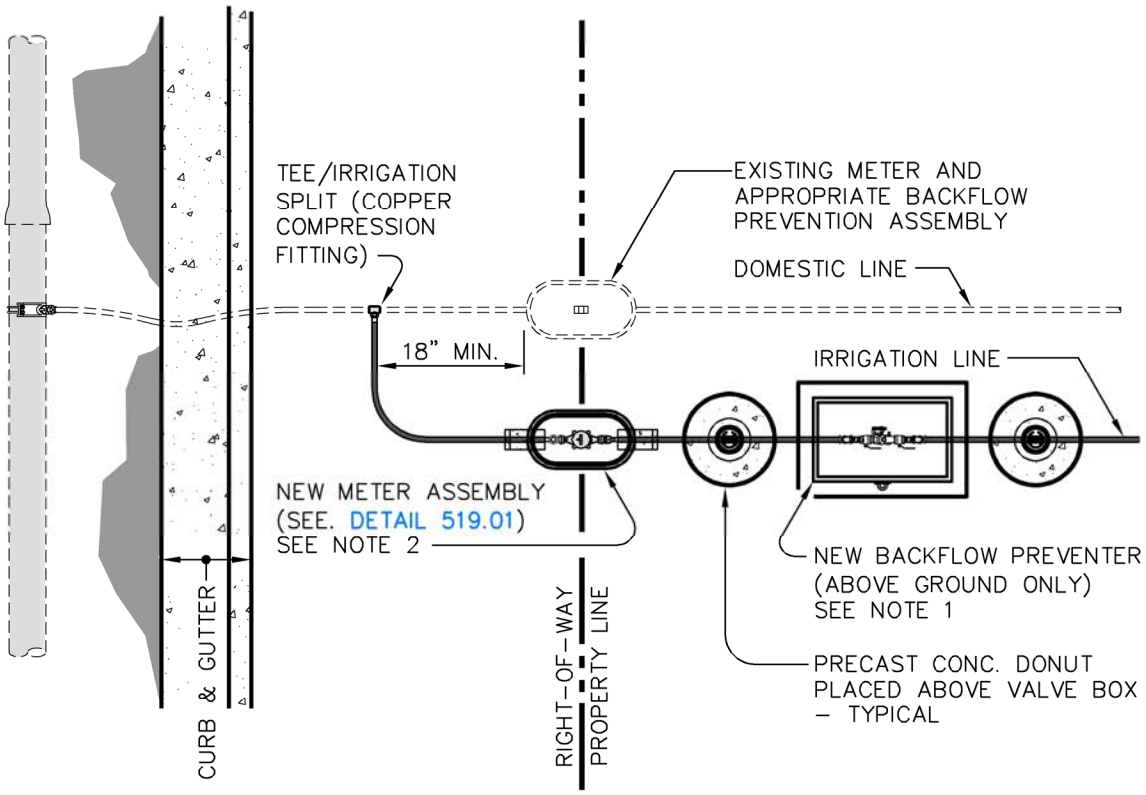
1. If 2 taps are made on each side of the main there shall be a minimum of 24" horizontal separation. Multiple taps on the same side shall have a minimum 24" horizontal separation and staggered a minimum of 1" vertically to prevent damage to the main.
2. See pre-approved product list for saddle model and for saddle model corresponding to type of pipe material.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD WATER TAP DETAIL (3/4" AND 1" TAPS)

SCALE:	DETAIL #
Not To Scale	2 513.04
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

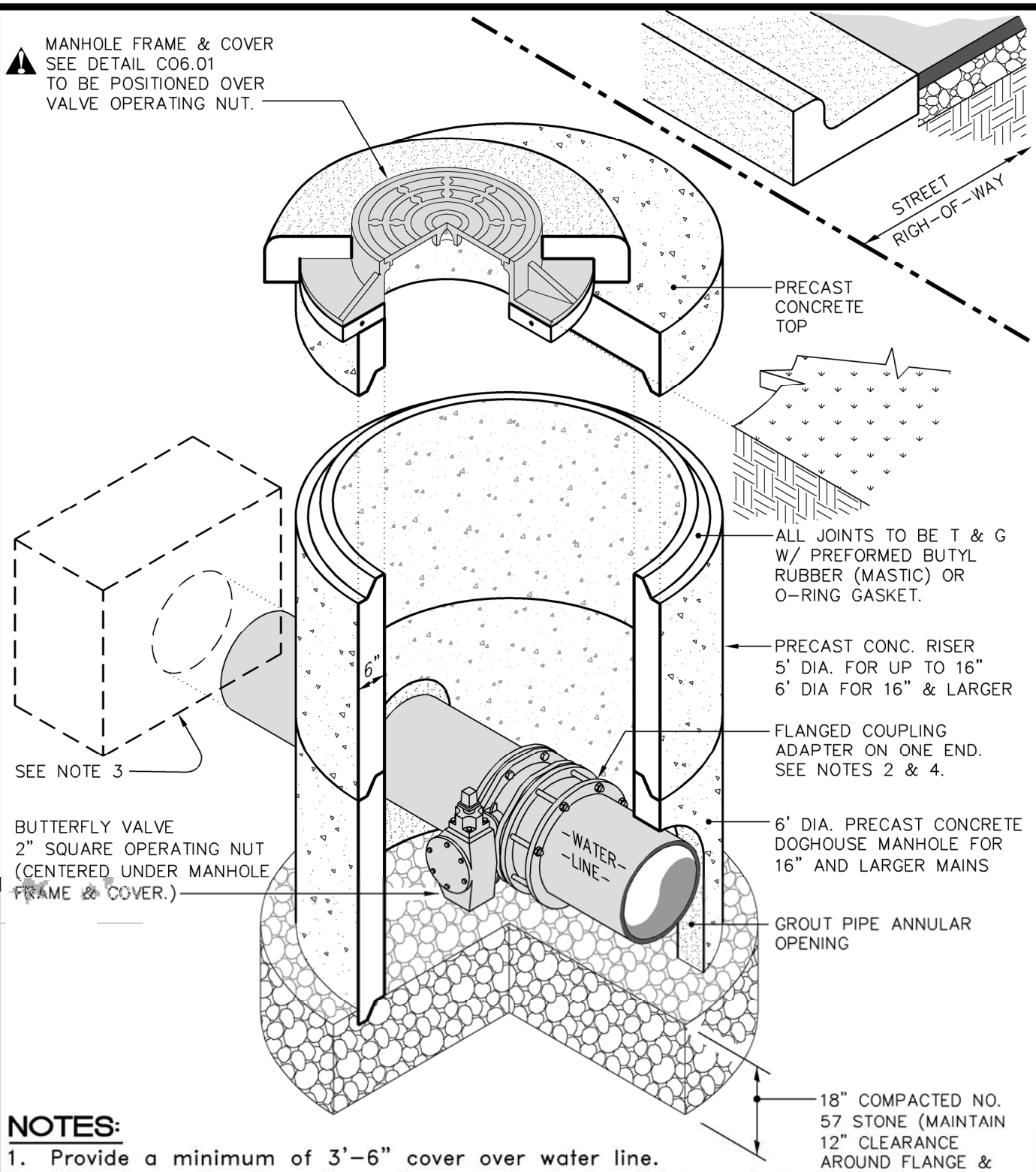
1. See detail 519.07 for new backflow preventer assembly.
2. See detail 519.01 for water meter assembly.
3. Designer to verify flows.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

IRRIGATION TAP TO EXISTING SMALL RESIDENTIAL SERVICE

SCALE:	DETAIL #
Not To Scale	2 513.06
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

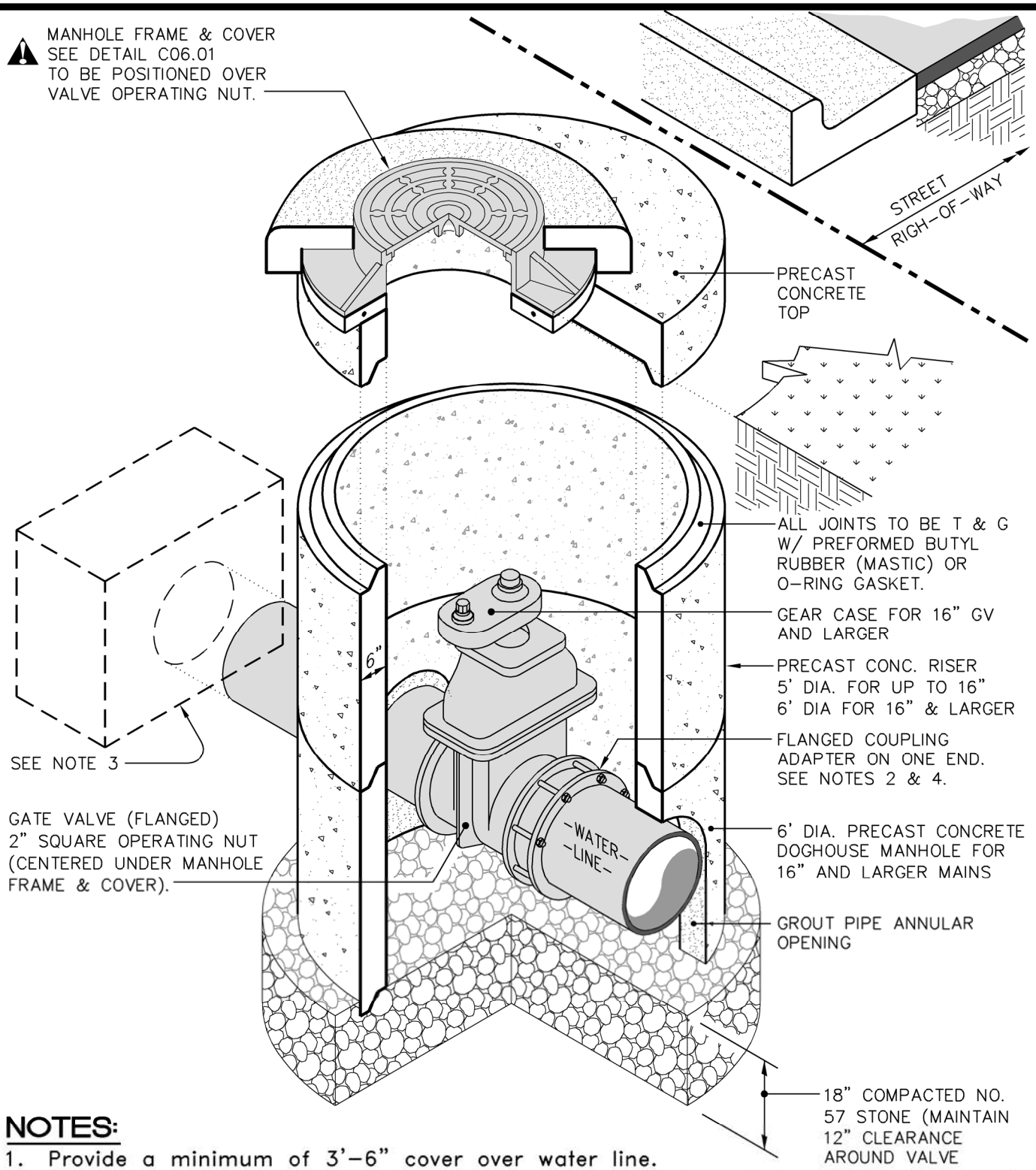
1. Provide a minimum of 3'–6" cover over water line.
2. All bolts on the flanged coupling adaptor to be stainless steel.
3. Thrust collar to be provided on both sides of manhole. See detail 512.02 for thrust collar detail.
4. Refer to Pre–Approved product list for manufacturer and model numbers.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

BUTTERFLY VALVE (16" and LARGER) in PRECAST MANHOLE

SCALE:	DETAIL #
Not To Scale	2 513.09
REVISION DATE:	SHEET #:
Oct., 2022	1 of 2



NOTES:

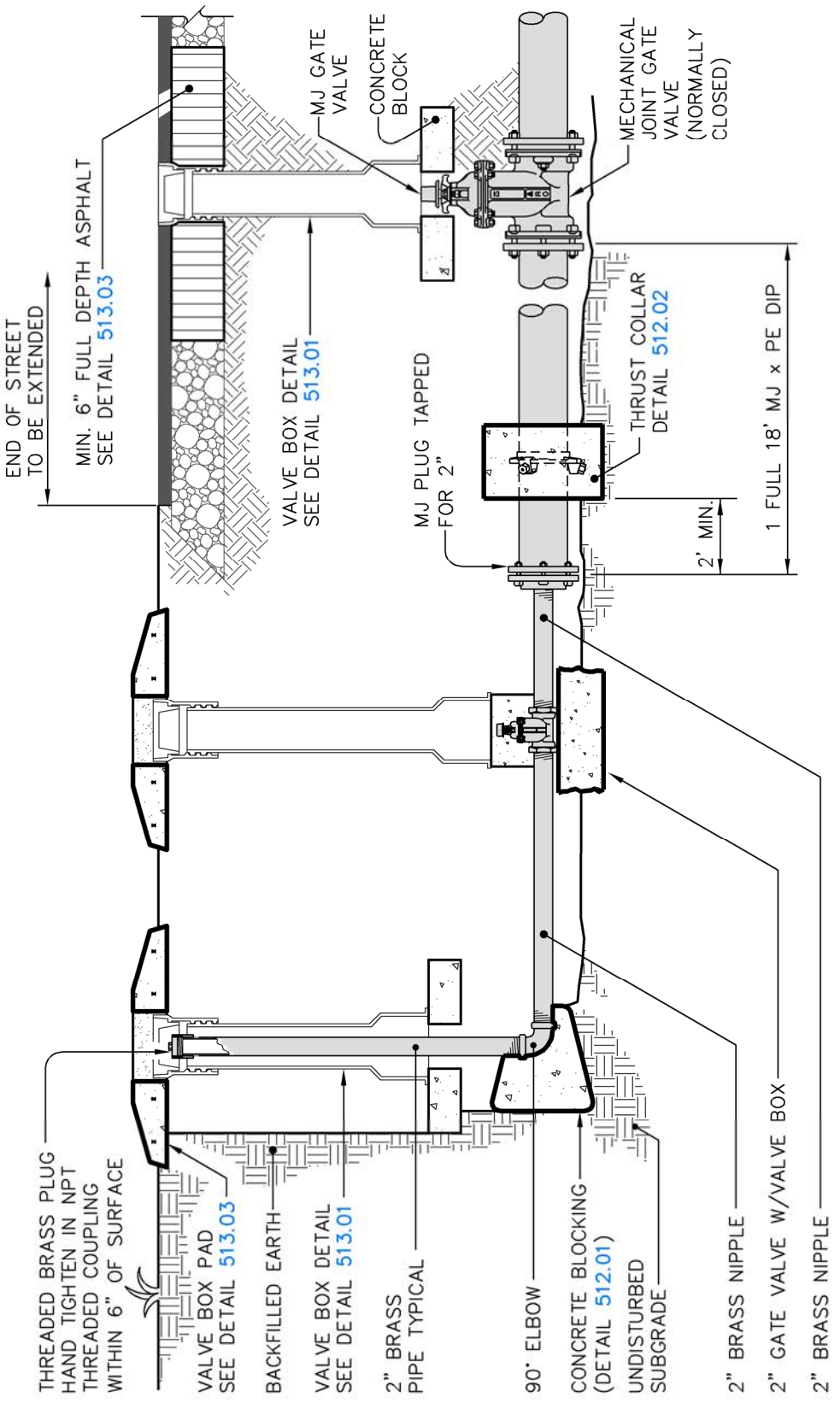
1. Provide a minimum of 3'–6" cover over water line.
2. All bolts on the flanged coupling adaptor to be stainless steel.
3. Thrust collar without rodding to be provided on both sides of manhole. See detail 512.02 for thrust collar detail.
4. Refer to Pre-Approved product list for manufacturer and model numbers.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

GEAR ACTUATED GATE VALVE (16" & LARGER) in PRECAST MANHOLE

SCALE:	DETAIL #
Not To Scale	2 513.09
REVISION DATE: July, 2023	SHEET #: 2 of 2



NOTES:

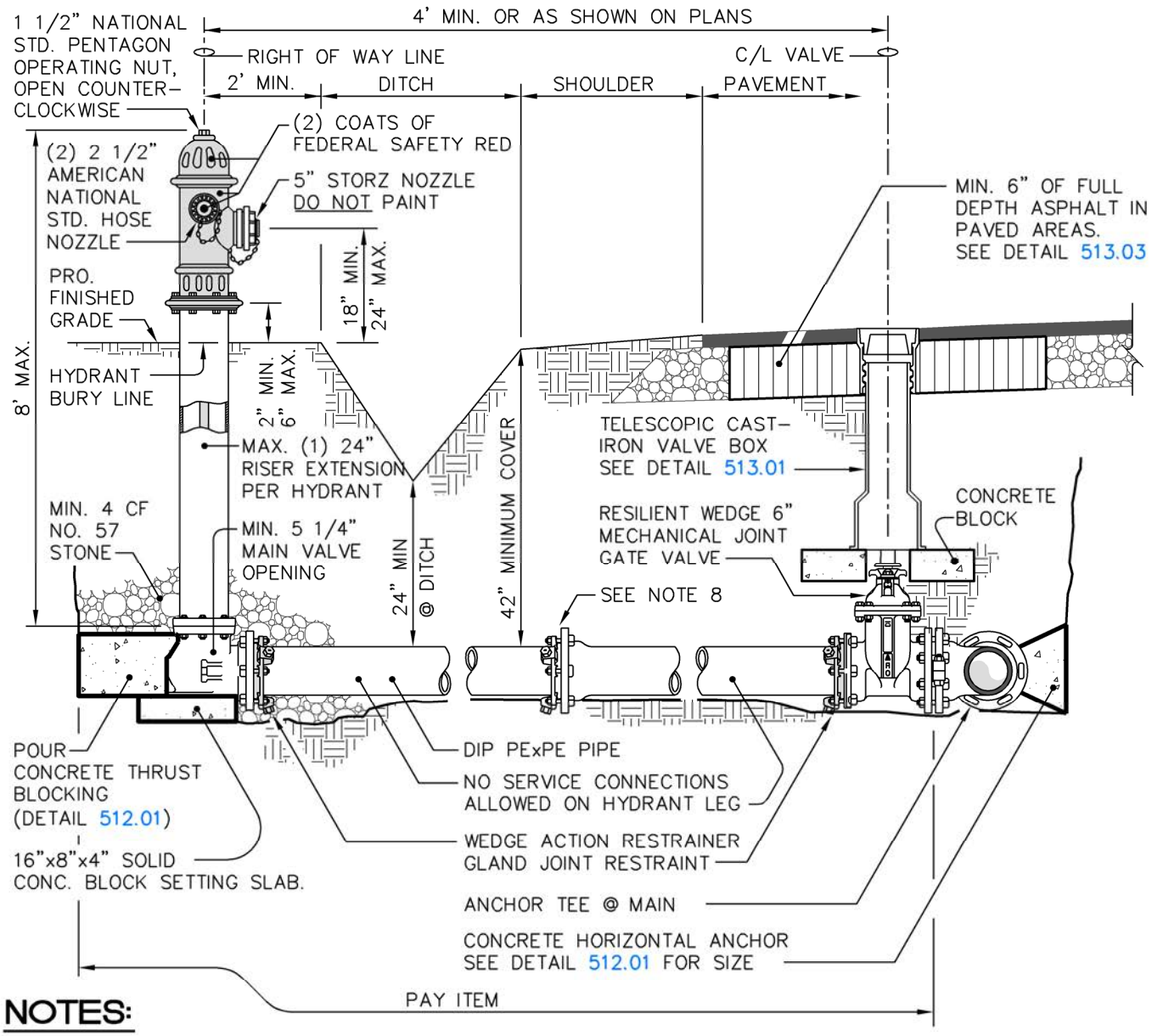
1. No discharge from blow-off should go directly into a creek. Dechlorinate discharge before it enters a body of water.
2. Provide erosion and sedimentation control for discharge.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TEMPORARY 2" BLOW-OFF ASSEMBLY FOR WATER MAINS

SCALE: Not To Scale	DETAIL # 2 514.01
REVISION DATE: April, 2024	SHEET #: 1 of 1



NOTES:

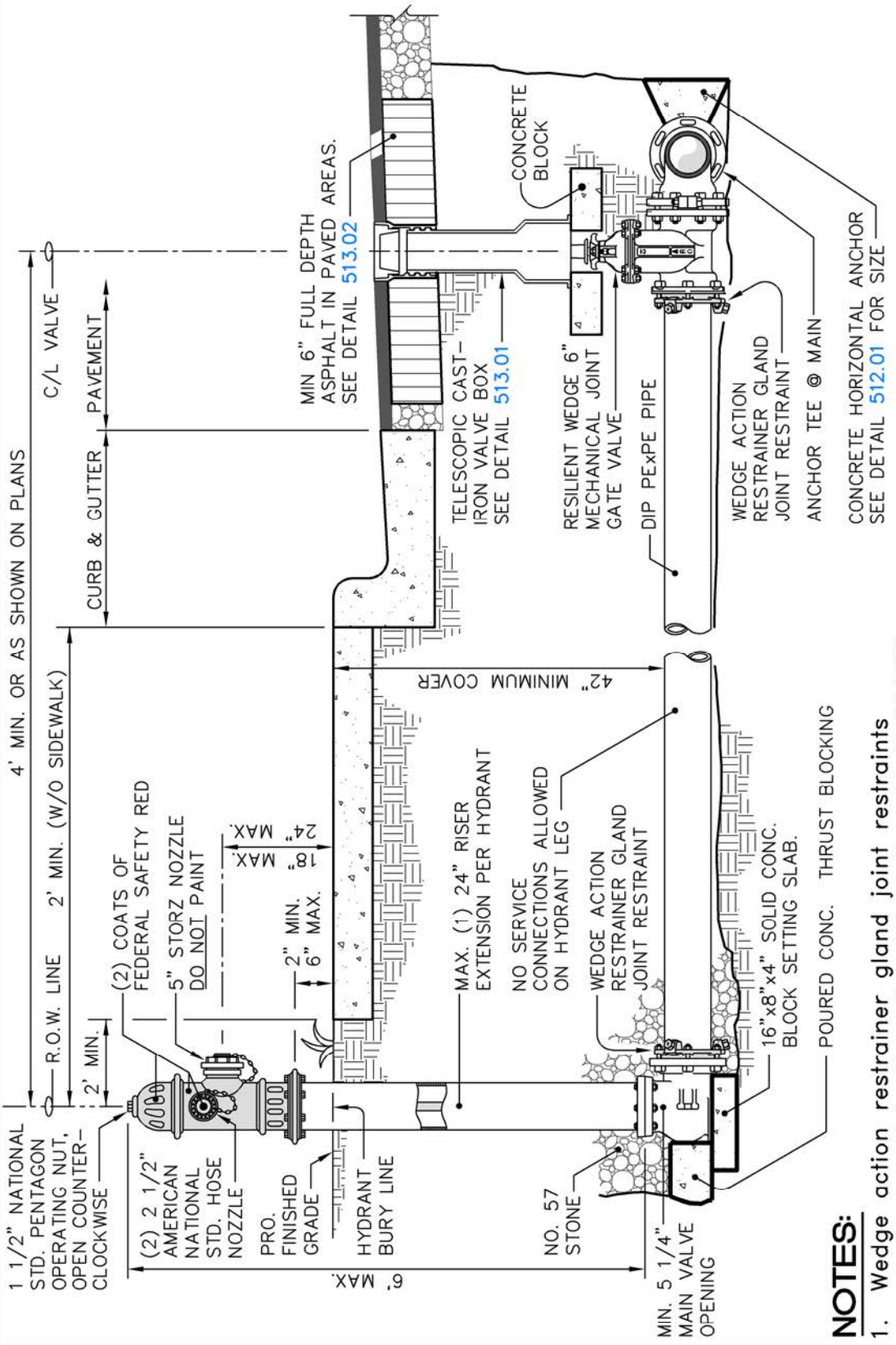
1. Wedge action restrainer gland joint restraints may be used in lieu of rodding. See detail 514.06.
2. Hydrants to be placed with pumper nozzle facing the street or as otherwise directed by Engineering Director.
3. When valve box is placed outside of pavement, provide concrete stabilization pad per detail 513.03.
4. Where hydrant is set behind guardrail, provide adequate horizontal separation as directed by fire department.
5. Fire hydrant to be oiled & greased and cap to be sprayed (Non-petroleum - based) after installation.
6. Omitted.
7. See pre-approved products list for manufacturer and model number.
8. If hydrant leg requires multiple segments of pipe, incorporate wedge action restrainer gland at all joints.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL FIRE HYDRANT STREETS with SIDE DITCH

SCALE:	DETAIL #
Not To Scale	514.04
REVISION DATE: April, 2024	SHEET #: 1 of 1



NOTES:

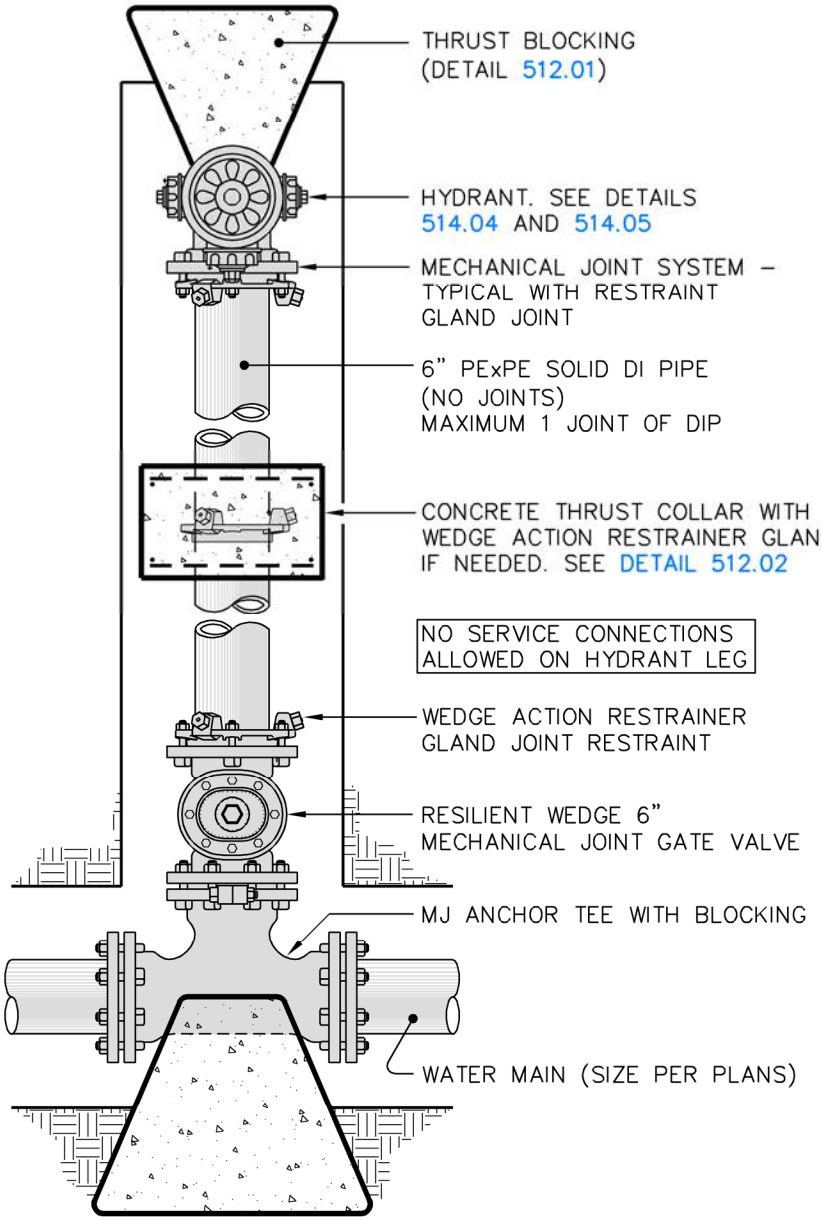
1. Wedge action restrainer gland joint restraints may be used in lieu of rodding. See detail 514.06.
2. Hydrants to be placed with pumper nozzle facing the street or as otherwise directed by Engineering Director.
3. When valve box is placed outside of pavement, Provide concrete stabilization pad per detail 513.03.
4. Where hydrant is set behind guardrail, provide adequate horizontal separation as directed by fire department.
5. Fire hydrant to be oiled & greased and cap to be sprayed (Non-petroleum based) after installation.
6. Do not locate hydrants in sidewalks or block pedestrian flow.
7. See pre-approved product list for manufacturer and model number.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL FIRE HYDRANT STREETS with CURB & GUTTER

SCALE:	DETAIL #
Not To Scale	514.05
REVISION DATE: April, 2024	SHEET #: 1 of 1

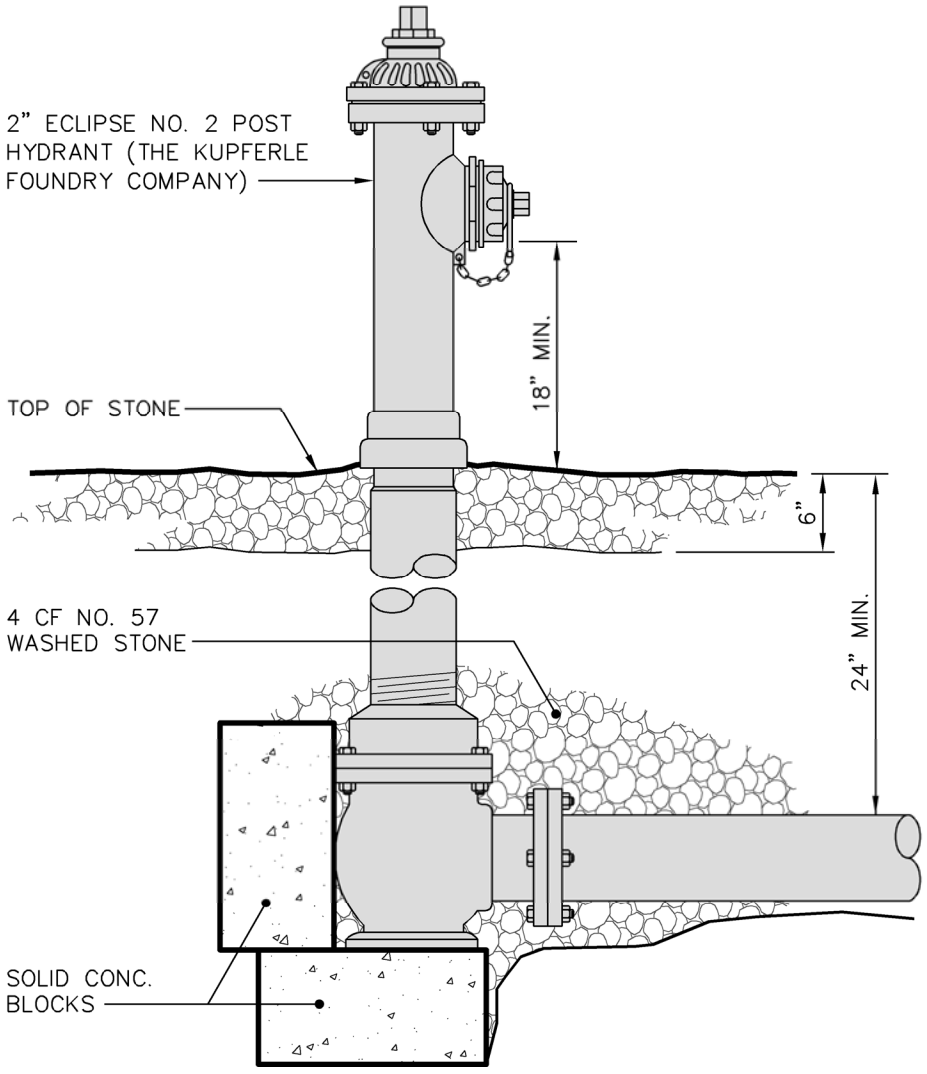


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

ALTERNATE HYDRANT SETTINGS JOINT RESTRAINT & R.S. GATE VALVE

SCALE:	DETAIL #
Not To Scale	2 514.06
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

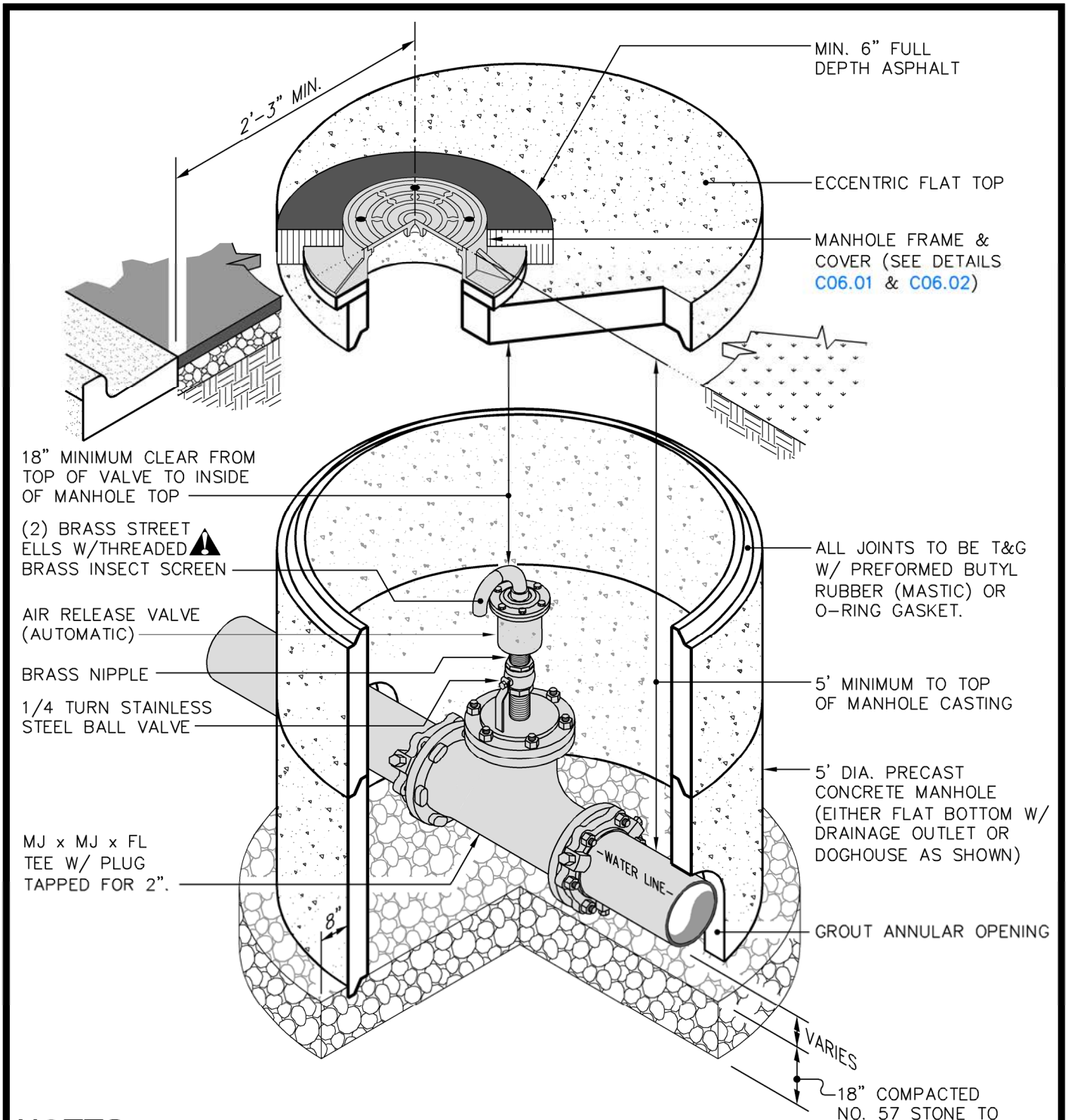
1. All flush hydrants require installation of RPZ backflow preventer per detail 519.07.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

FLUSHING HYDRANT (ABOVE GROUND, NON-FREEZE)

SCALE:	DETAIL #
Not To Scale	2 514.08
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

1. Provide a minimum of 3'–6" cover over water line.
2. All pipe fittings to be stainless steel.
3. Cone section may be substituted for flat top if depth permits.
4. Water main shall be 1 full joint DIP.
5. Refer to Pre–Approved product list for manufacturer and model numbers.

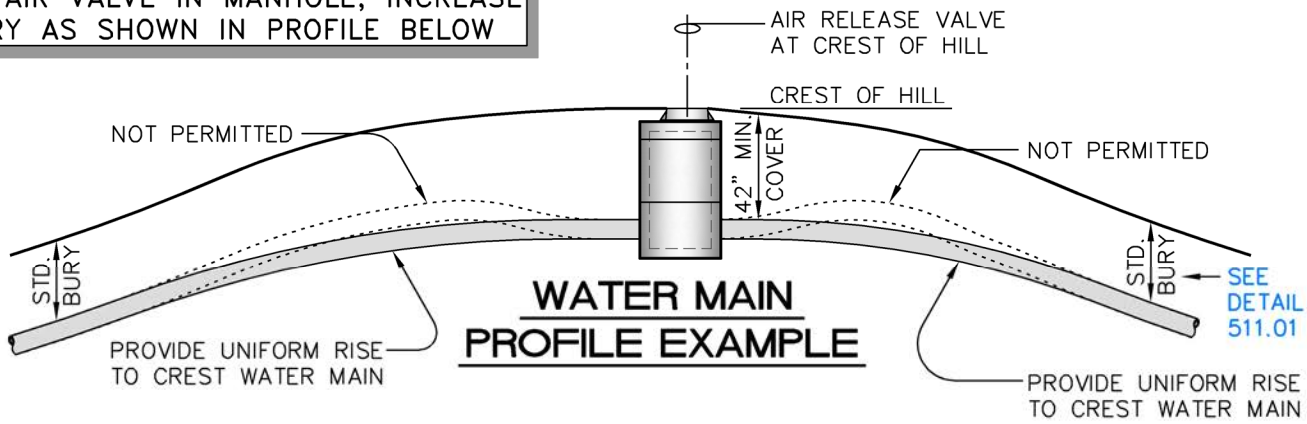
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

WATER MAIN AIR RELEASE MANHOLE

SCALE:	DETAIL #
Not To Scale	2 516.01
REVISION DATE: Oct., 2022	SHEET #: 1 of 2

TO OBTAIN MIN. CLEARANCE AT TOP OF AIR VALVE IN MANHOLE, INCREASE BURY AS SHOWN IN PROFILE BELOW



WATER MAIN PROFILE EXAMPLE

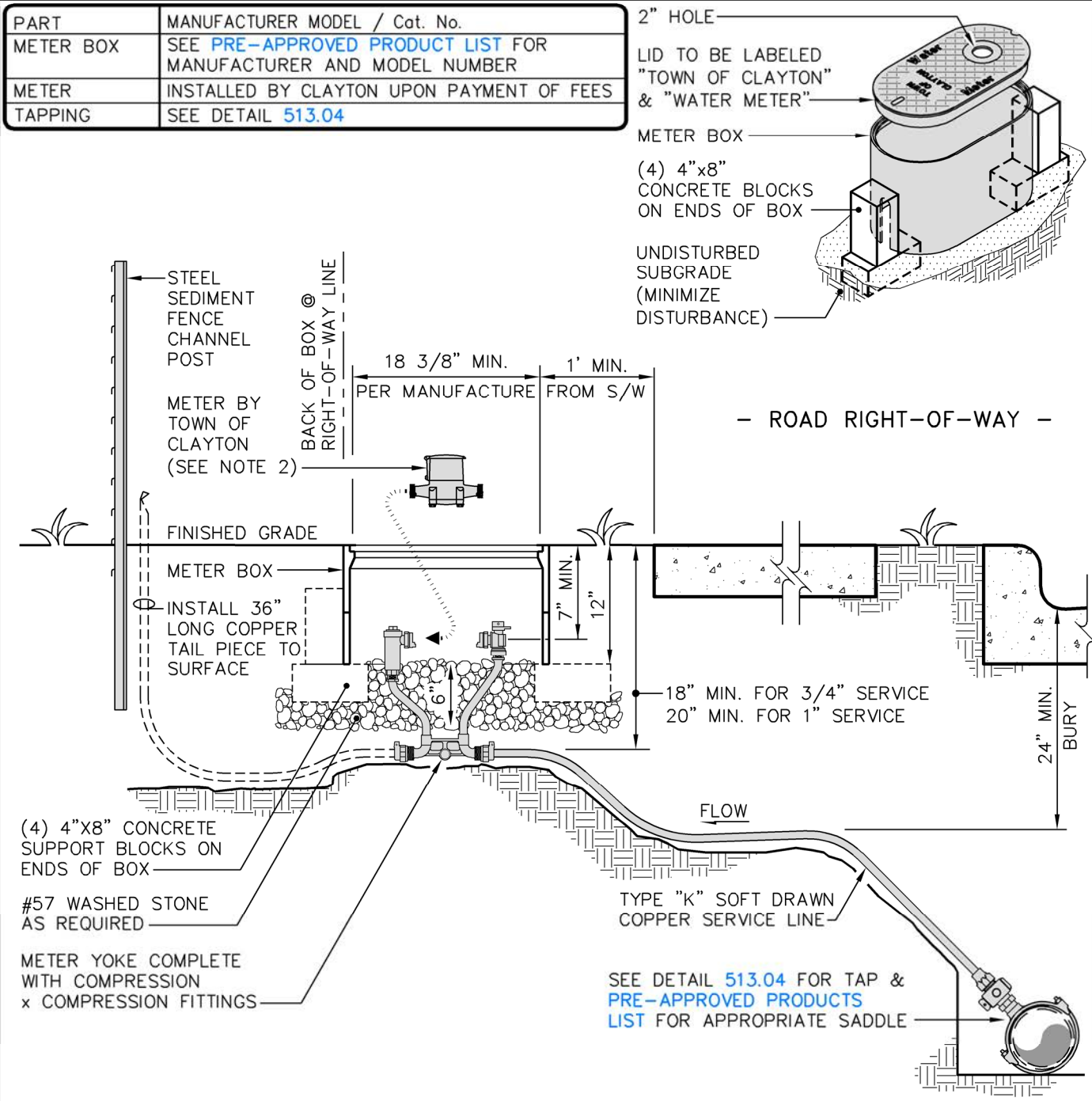
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

WATER MAIN AIR RELEASE MANHOLE

SCALE:	DETAIL #
Not To Scale	516.01
REVISION DATE:	SHEET #:
Oct., 2022	2 of 2

PART	MANUFACTURER MODEL / Cat. No.
METER BOX	SEE PRE-APPROVED PRODUCT LIST FOR MANUFACTURER AND MODEL NUMBER
METER	INSTALLED BY CLAYTON UPON PAYMENT OF FEES
TAPPING	SEE DETAIL 513.04



NOTES:

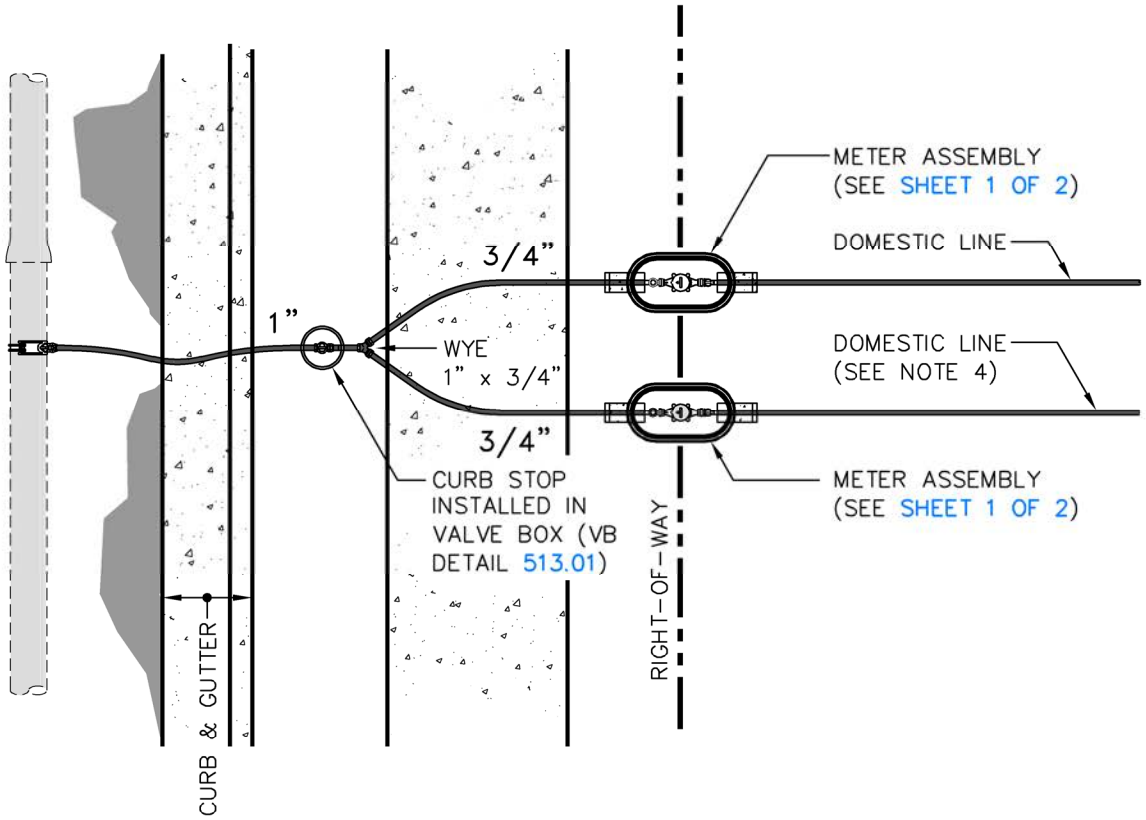
1. Contractor to place meter box in non-traffic area only.
2. Meter must be level across meter connections.
3. No service taps to be installed on hydrant legs.
4. Min 5' easement required on all sides of meter.
5. Town Maintenance ends at Right-of-Way.
6. All fittings and apparatus to be lead free.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" & 1" WATER METER SERVICE DETAIL

SCALE:	DETAIL #
Not To Scale	519.01
REVISION DATE: Oct., 2022	SHEET #: 1 of 2



NOTES:

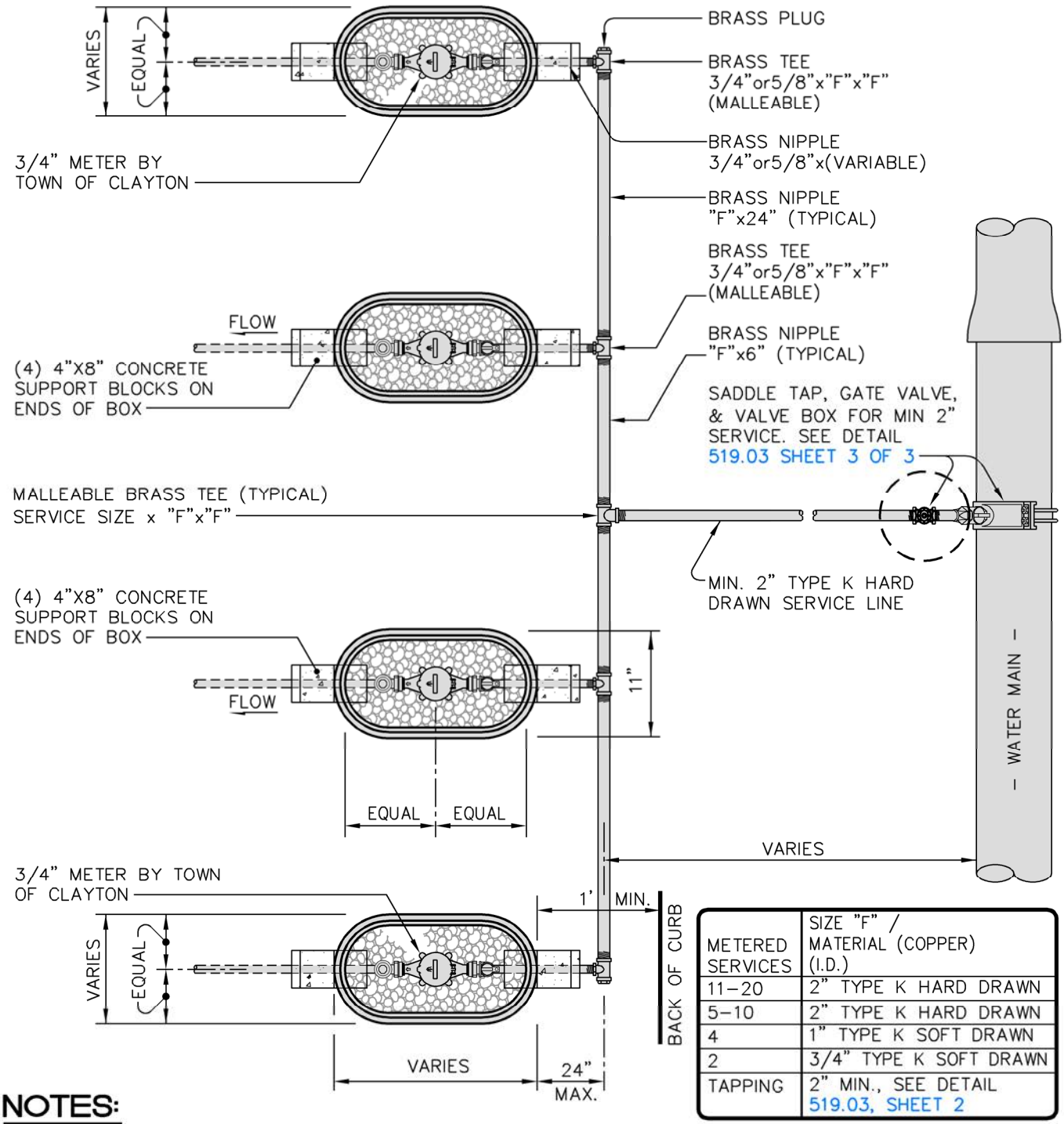
1. See detail 513.03 for top of valve box treatment.
2. See detail sheet 1 of 2 for water meter assembly.
3. This detail to be used when directed by Engineering Director.
4. Refer to detail 513.06 for BFP when one of the 3/4" legs is to be used for irrigation.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TAP for DUPLEX SERVICE or IRRIGATION USE

SCALE:	DETAIL #
Not To Scale	2 519.01
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



METERED SERVICES	SIZE "F" / MATERIAL (COPPER) (I.D.)
11–20	2" TYPE K HARD DRAWN
5–10	2" TYPE K HARD DRAWN
4	1" TYPE K SOFT DRAWN
2	3/4" TYPE K SOFT DRAWN
TAPPING	2" MIN., SEE DETAIL 519.03, SHEET 2

NOTES:

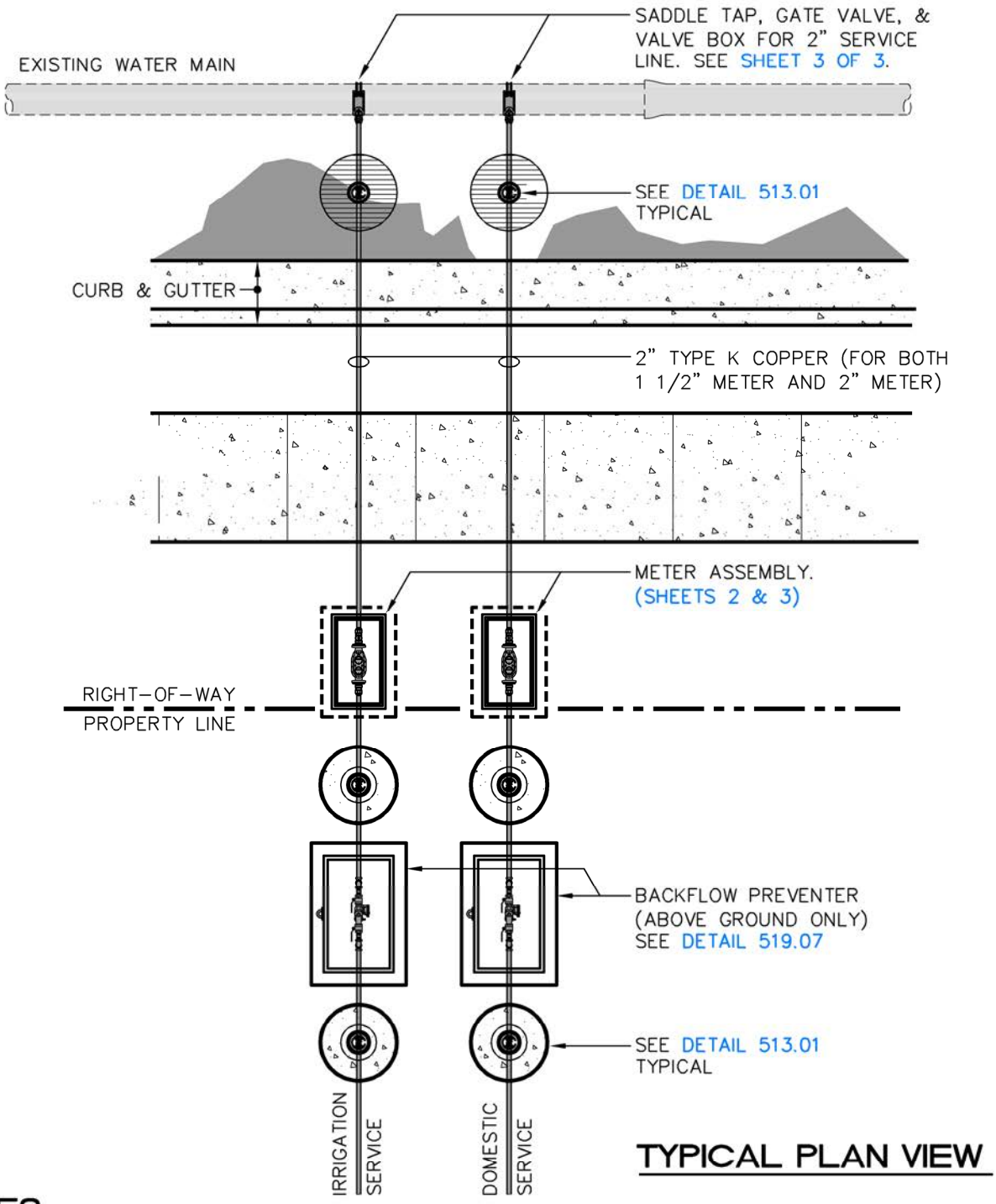
1. Contractor to place meter boxes in non–traffic area only.
2. Meter must be level across meter connections.
3. Substitution requires approval by Engineering Director.
4. See detail 519.01, sheet 1 of 2 for meter installation detail.
5. This detail only to be used in non–residential applications. Engineering Director approval is required.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD GANG METER ASSEMBLY

SCALE:	DETAIL #
Not To Scale	2 519.02
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



TYPICAL PLAN VIEW

NOTES:

1. See detail 519.07 for backflow preventer assembly.
2. See sheets 2 & 3 for 2" tap & water meter assembly.
3. Designer to verify flows.

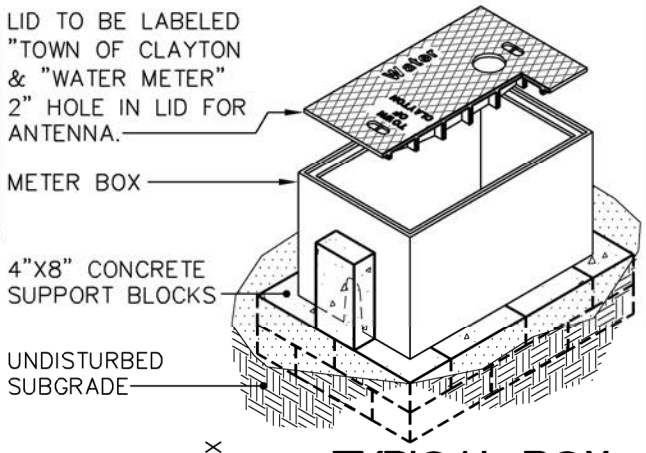
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

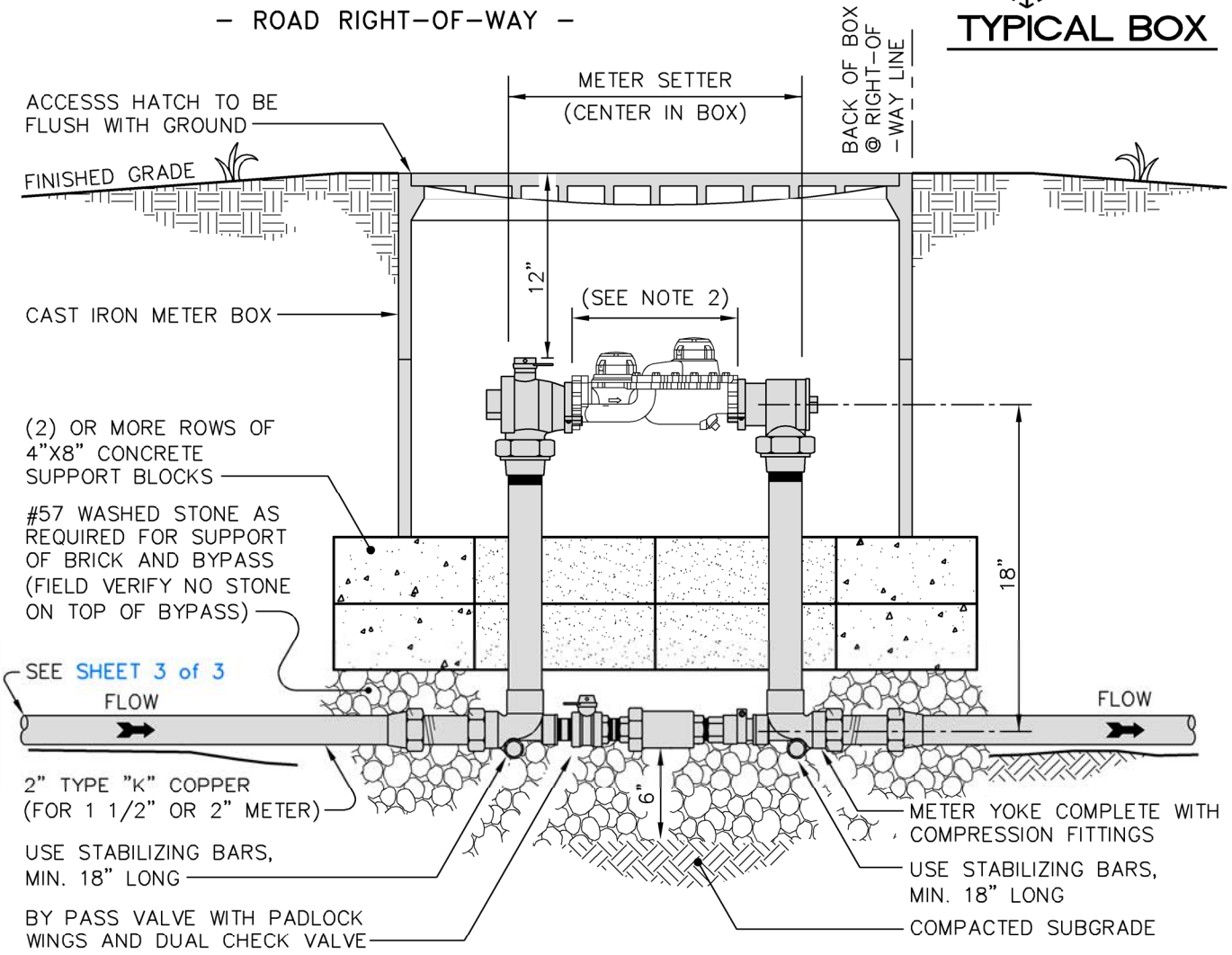
1 1/2" & 2" COMMERCIAL WATER METER SERVICE DETAIL

SCALE:	DETAIL #
Not To Scale	519.03
REVISION DATE: Oct., 2022	SHEET #: 1 of 3

PART	MANUFACTURER MODEL / Cat. No.
METER BOX	SEE PRE-APPROVED PRODUCT LIST FOR MANUFACTURER AND MODEL NUMBER
METER SETTER	SEE PRE-APPROVED PRODUCT LIST FOR MANUFACTURER AND MODEL NUMBER
METER	PROVIDED & INSTALLED BY CONTRACTOR IN ACCORDANCE WITH TOWN SPECIFICATIONS
TAPPING	SEE SHEET 3 OF 3



TYPICAL BOX



NOTES:

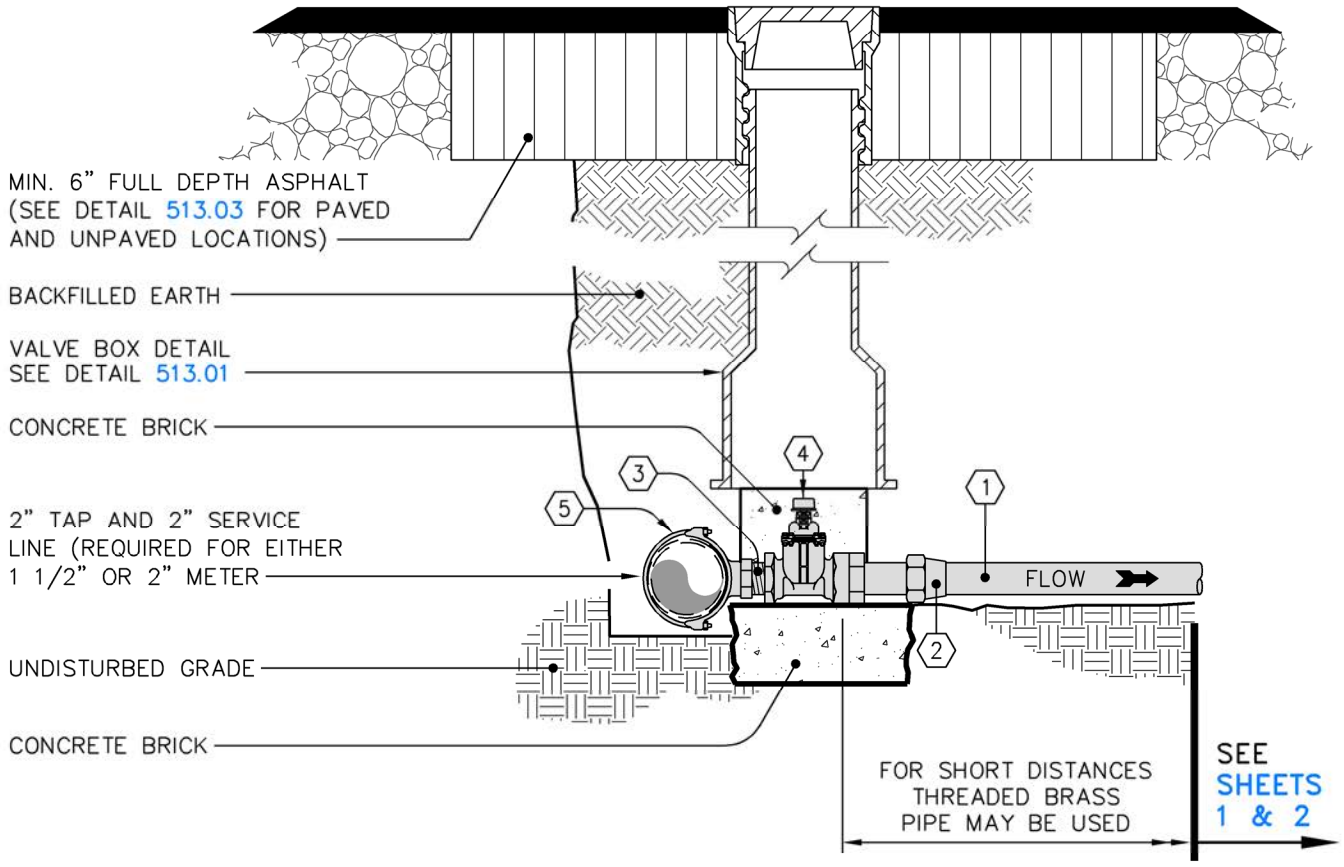
1. Contractor to place meter box in non-traffic area only.
2. Meter must be level across meter connections.
3. Ensure positive surface grade away from vault.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

1 1/2" & 2" COMMERCIAL WATER METER SERVICE DETAIL

SCALE:	DETAIL #
Not To Scale	519.03
REVISION DATE: Oct., 2022	SHEET #: 2 of 3



STANDARD 2" TAP

(#)	PART	MANUFACTURER MODEL / Cat. No.
1	TYPE "K" HARD DRAWN COPPER SERVICE	---
2	MALE THREAD x COMPRESSION ADAPTER	MUELLER H15423 OR APPROVED EQUAL
3	2" THREADED BRASS CLOSE NIPPLE	---
4	2" THREADED IRON BODY GATE VALVE RESILIENT WEDGE	SEE PRE-APPROVED PRODUCTS LIST
5	BRONZE DOUBLE STRAP SADDLE	SEE PRE-APPROVED PRODUCTS LIST

NOTES:

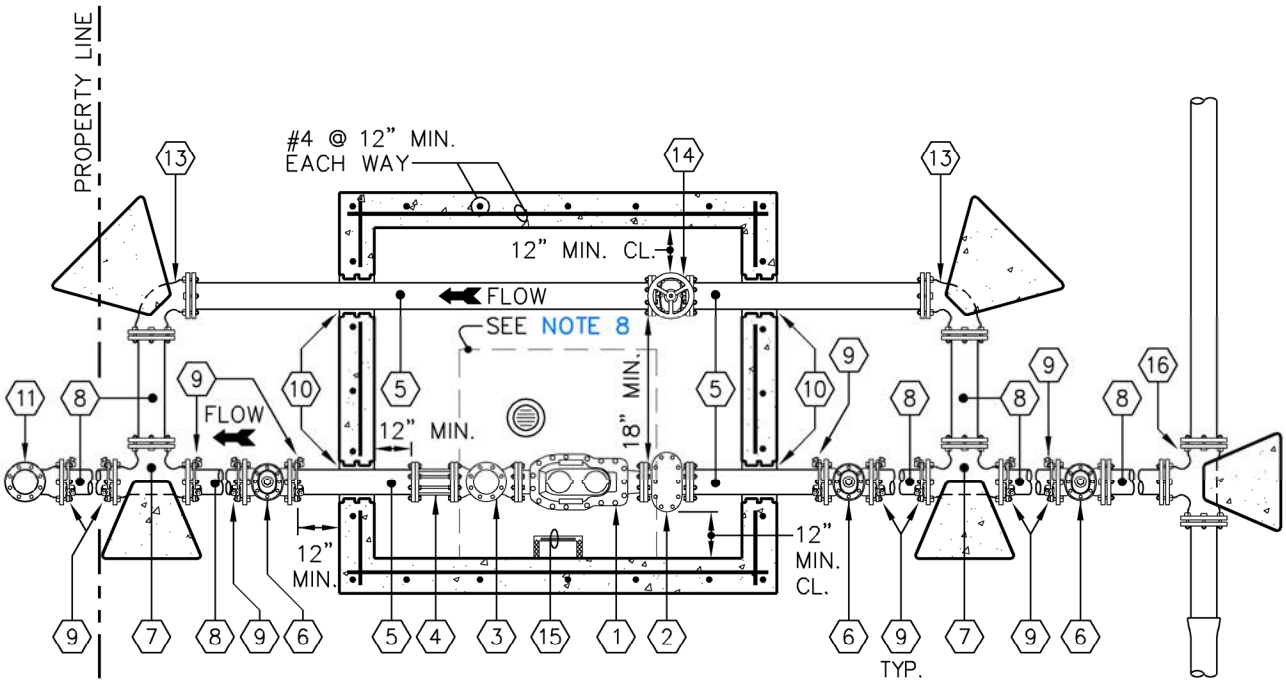
1. All taps larger than 2" shall be made with Tapping sleeve and Valve (Detail 513.02)

TOWN of CLAYTON

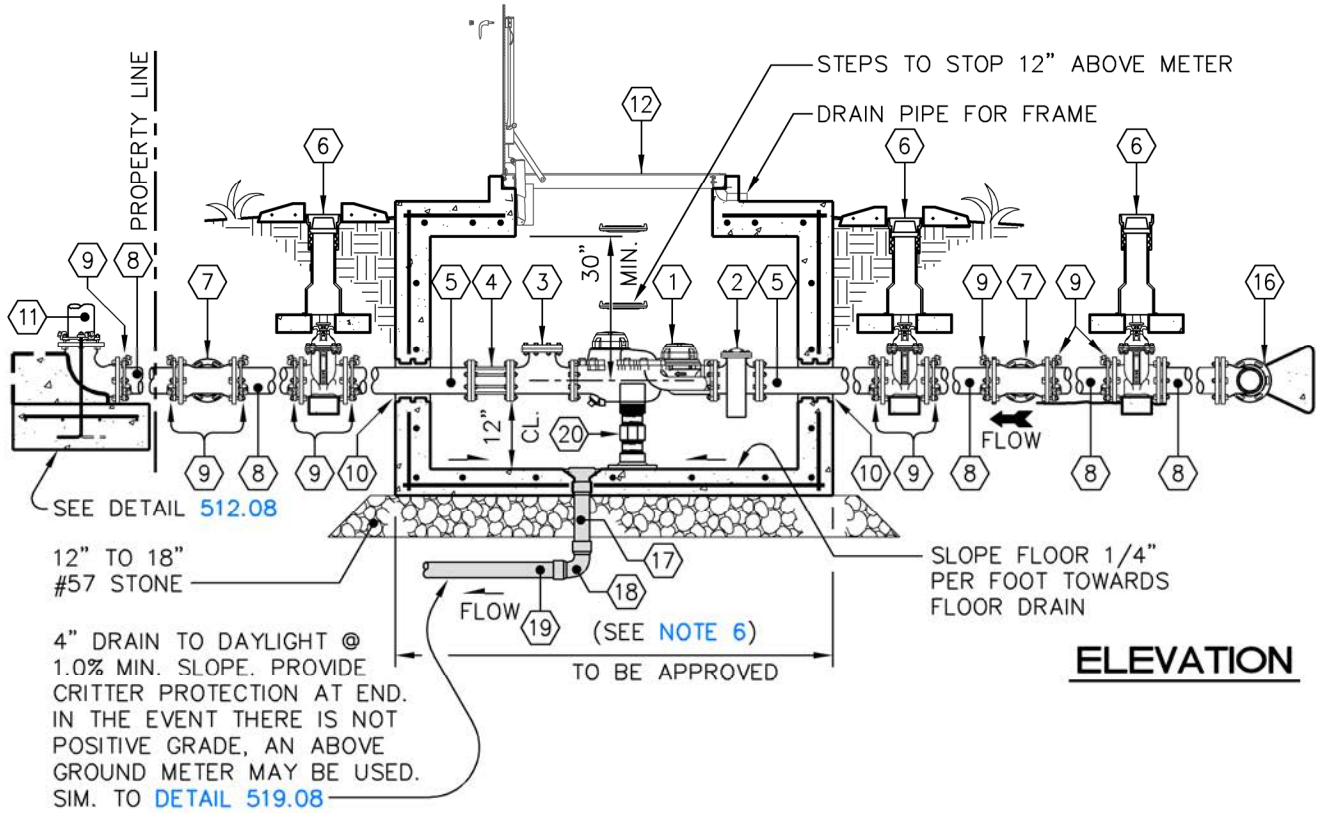
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

1 1/2" & 2" COMMERCIAL WATER METER SERVICE DETAIL

SCALE:	DETAIL #
Not To Scale	2519.03
REVISION DATE:	SHEET #:
Oct., 2022	3 of 3



PLAN



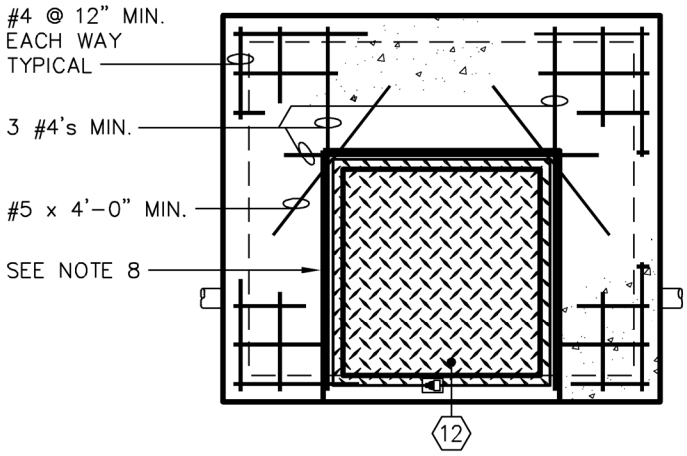
ELEVATION

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" thru 8" WATER METER WITH BYPASS INSTALLATION

SCALE:	DETAIL #
Not To Scale	2519.04
REVISION DATE:	SHEET #:
Oct., 2022	1 of 2



#	PART	MANUFACTURER MODEL / CAT. NO
1	COMPOUND METER	SEE PRE APPROVED PRODUCTS LIST
2	STRAINER	3" THRU 6" = BRONZE STRAINER 8" = CAST IRON STRAINER
3	DIP CLASS 350 TEE (FLANGED) (NOTE 4)	TO BE APPROVED BY TOWN
4	COUPLING ADAPTOR (FLANGED)	TO BE APPROVED BY TOWN
5	DIP CLASS 350 NIPPLE (FLANGE x PE)	AMERICAN, GRIFFIN, OR U.S. PIPE
6	MJ GATE VALVE WITH VALVE BOX	PER DETAILS 513.01 & 513.03
7	DIP CLASS 350 MJ TEE W/BLOCKING	PER DETAIL 512.01
8	DIP CLASS 350 NIPPLE (PE x PE)	AMERICAN, GRIFFIN, OR U.S. PIPE
9	WEDGE ACTION RESTRAINER GLAND	SEE PRE-APPROVED PRODUCTS LIST
10	WALL SLEEVE WITH LINK SEAL OR APPROVED EQUAL	TO BE APPROVED BY TOWN
11	TO APPROVED BACKFLOW PREVENTION	PER DETAIL 519.08
12	36"x36" ACCESS HATCH WITH FALL PROTECTION AND PADLOCK LUGS (PIN OR FLAT ANGLES)	BILCO, HALLIDAY, OR US FOUNDRY
13	DIP CLASS 350 MJ BEND W/BLOCKING	PER DETAIL 512.01
14	NRS GATE VALVE WITH HAND WHEEL – NORMALLY CLOSED (FLANGED)	SEE PRE-APPROVED PRODUCTS LIST
15	STEP	PER DETAIL C06.04
16	MJ TEE	SEE PRE-APPROVED PRODUCTS LIST
17	FLOOR DRAIN	JAY R. SMITH MFG CO. / 2005 or APPROVED EQUAL
18	4" CISP OR PVC SCH 40 BEND	SEE PRE-APPROVED PRODUCTS LIST
19	4" CISP OR PVC SCH 40	SEE PRE-APPROVED PRODUCTS LIST
20	ALUM OR SS STAND ON SUPPORT W/O BOLT	SEE PRE-APPROVED PRODUCTS LIST

NOTES:

1. Meter and tee to be installed by contractor in accordance with specifications but approved prior to installation.
2. Strainer, meter, flanged coupling, and bypass valve to be inside meter vault.
3. Flanged tee is not required when meter has a test port.
4. 12" clearance around all connections inside vault from floor & walls.
   18" clearance between meter and bypass piping.
5. Ensure positive surface grade away from box.
6. Concrete vault size & rebar to be per NCPE and approved by the Town.
7. Concrete vault design per manufacturers specifications and approved cut sheets.
8. Hatch to be centered over actual meter and strainer as appropriate.

TOWN of CLAYTON

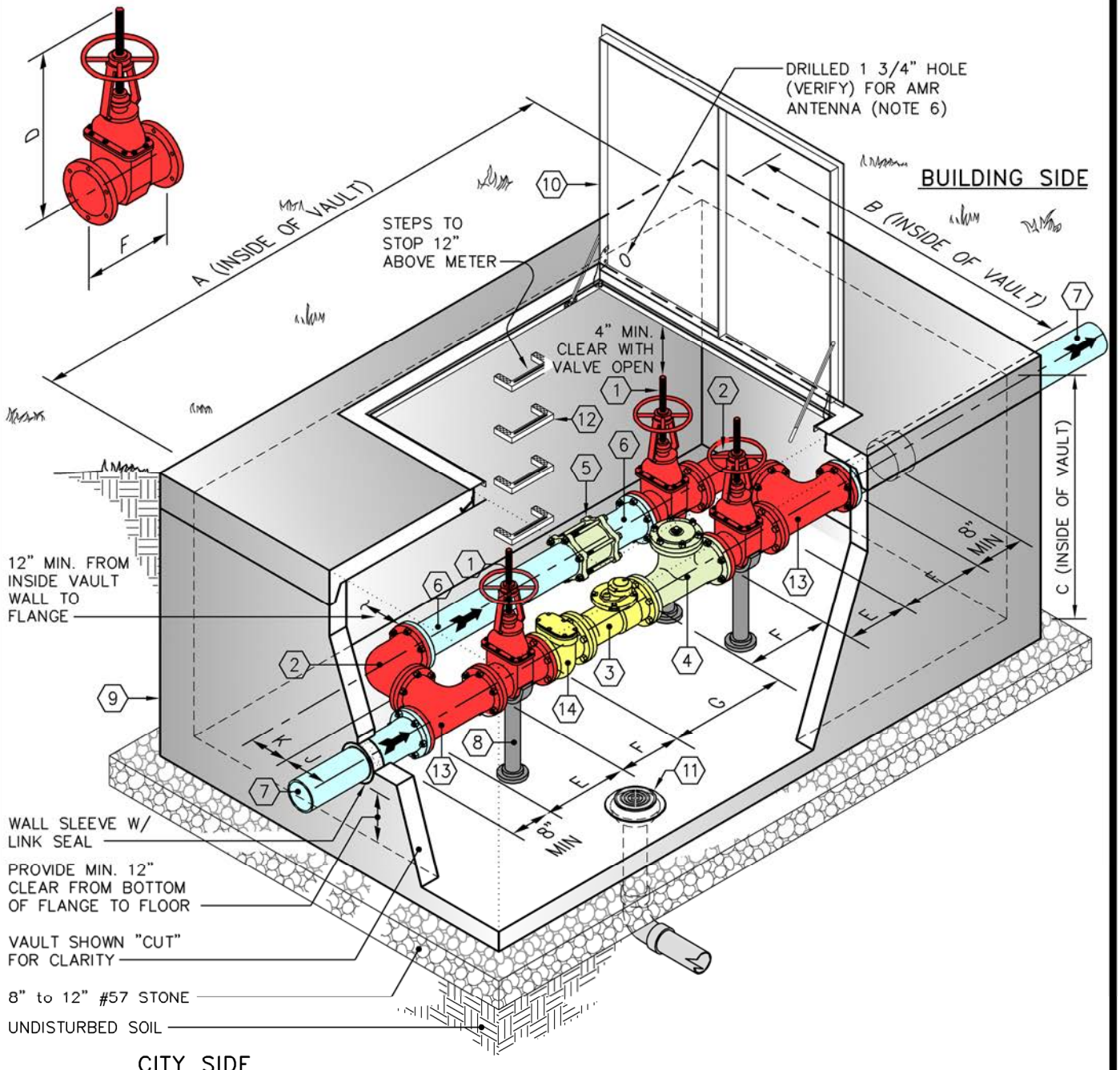
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" thru 8" WATER METER WITH BYPASS INSTALLATION

SCALE:	DETAIL #
Not To Scale	519.04
REVISION DATE: Oct., 2022	SHEET #: 2 of 2

PART DIMENSIONS									
METER SIZE	A	B	C	D *	E	F	G	J	K
3	8'–0"	4'–0"	3'–4"	1'–7 5/16"	11"	8"	17"	5 1/2"	5 1/2"
4	10'–0"	6'–0"	4'–0"	1'–11 11/16"	13"	9"	20"	6 1/2"	6 1/2"

* DIMENSIONS WILL VARY SLIGHTLY DEPENDING ON MANUFACTURER



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" AND 4" COMPOUND WATER METER INSTALLATION

SCALE:	DETAIL #
Not To Scale	2519.05
REVISION DATE: Oct., 2022	SHEET #: 1 of 2

#	PART DESCRIPTION
1	OS&Y GATE VALVE WITH RESILIENT SEATS
2	DIP CLASS 350 90° BEND (FLANGED)
3	COMPOUND WATER METER, SEE PRE-APPROVED PRODUCTS LIST
4	DIP CLASS 350 TEE WITH 2" BRONZE TAPPING PLUG
5	COMPRESSION FITTING
6	DIP CLASS 350 NIPPLE (FLANGED) LENGTH VARIES
7	DIP CLASS 350 (FLANGED x PE)
8	ALUM. OR SS STANDON ADJUSTABLE PIPE SUPPORTS. SEE PRE-APPROVED PRODUCTS LIST
9	PRECAST CONCRETE VAULT (SEE CHART FOR SIZE)
10	TOWN OF CLAYTON SINGLE LEAF ALUMINUM DOOR. CENTER OVER METER
11	4" DRAIN TO DAYLIGHT @ 1.0% MIN SLOPE. PROVIDE CRITTER PROTECTION SCREEN AT END. IN THE EVENT THERE IS INSUFFICIENT NEGATIVE GRADE, AN ABOVE GROUND METER MAY BE USED SIM. TO DETAIL 519.08
12	STEPS @ 12" O/C, SEE PRE-APPROVED PRODUCTS LIST
13	DIP CLASS 350 TEE
14	STRAINER

NOTES:

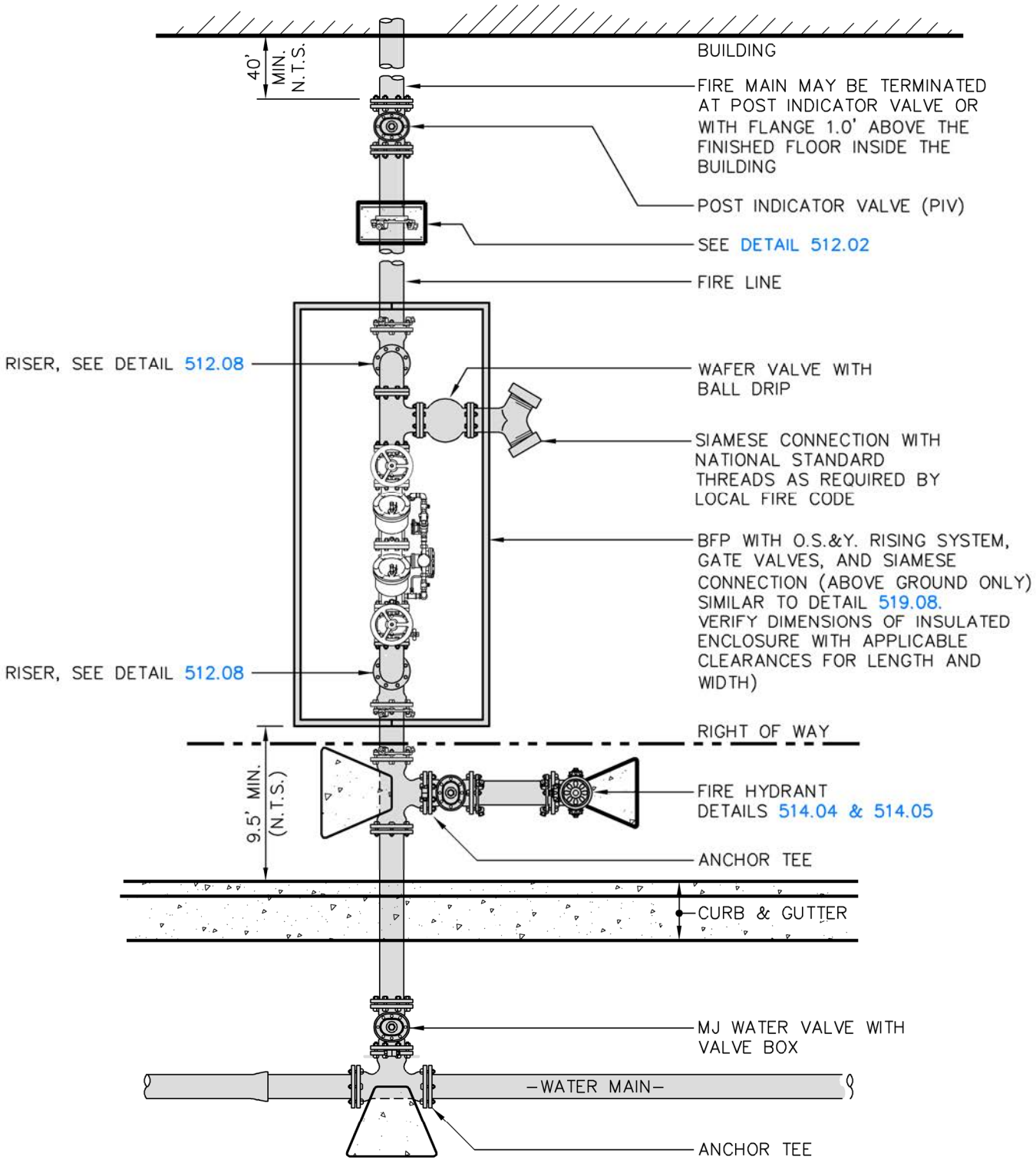
1. Pipes, bends, tees, and gate valves are the same size as the meter size. (i.e. 4" meter has 4" pipe, 4" 90° bends, 4"x4" tees and 4" gate valves.)
2. All dimensions are based upon standard sizes for pipes, bends, tees, gate valves and meters. Strainer sizes vary depending on manufacturer. Dimension "G" is based upon Sensus meter and strainer combination. If another manufacturer is being used this dimension will vary and the meter installation may not fit into the vault box shown. This should be checked before ordering the vault box. Coordinate with Town of Clayton Water Resources.
3. Use appropriate size plate flange on the tee with a 2" bronze tapping plug.
4. Use only meters, strainers and gate valves approved by Town of Clayton Water Resources. See pre-approved product list.
5. For 3" meter vaults use the standard single hatch-type aluminum door, centered over the meter. For 4" meter vaults use 5'x5' standard access door.
6. Drill lid for AMR antenna & epoxy AMR into lid.
7. Sizing of 3" and larger water meters must be submitted by a Professional Engineer as part of the construction drawings review.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" AND 4" COMPOUND WATER METER INSTALLATION

SCALE:	DETAIL #
Not To Scale	519.05
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



NOTES:

1. Fire mains to be pressure tested at 200 PSI.
2. BFP may be located inside building with Engineering Director.

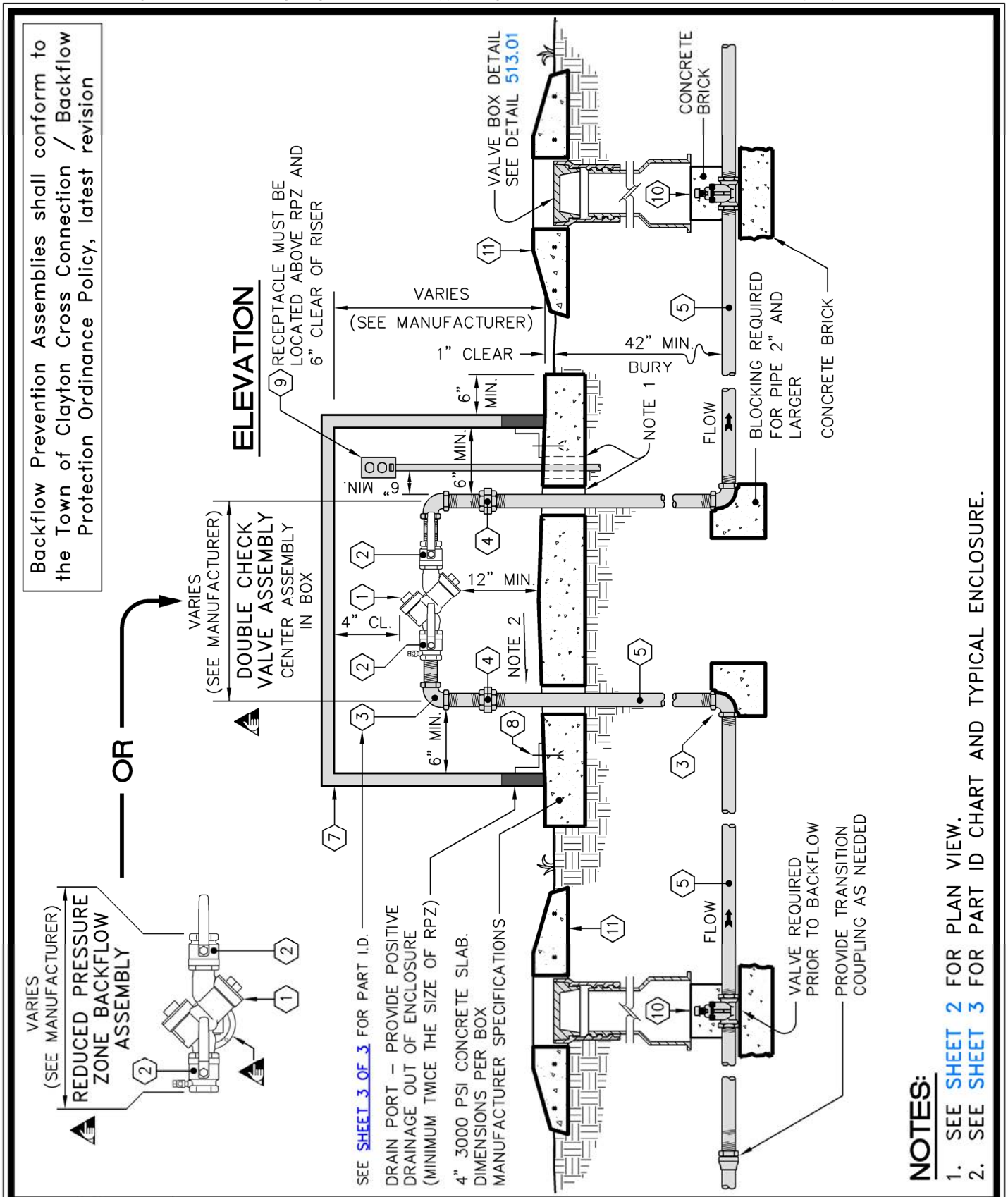
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

FIRE MAIN DETAIL

SCALE:	DETAIL #
Not To Scale	2519.06
REVISION DATE: Oct., 2022	SHEET #: 1 of 1

Backflow Prevention Assemblies shall conform to the Town of Clayton Cross Connection / Backflow Protection Ordinance Policy, latest revision



NOTES:

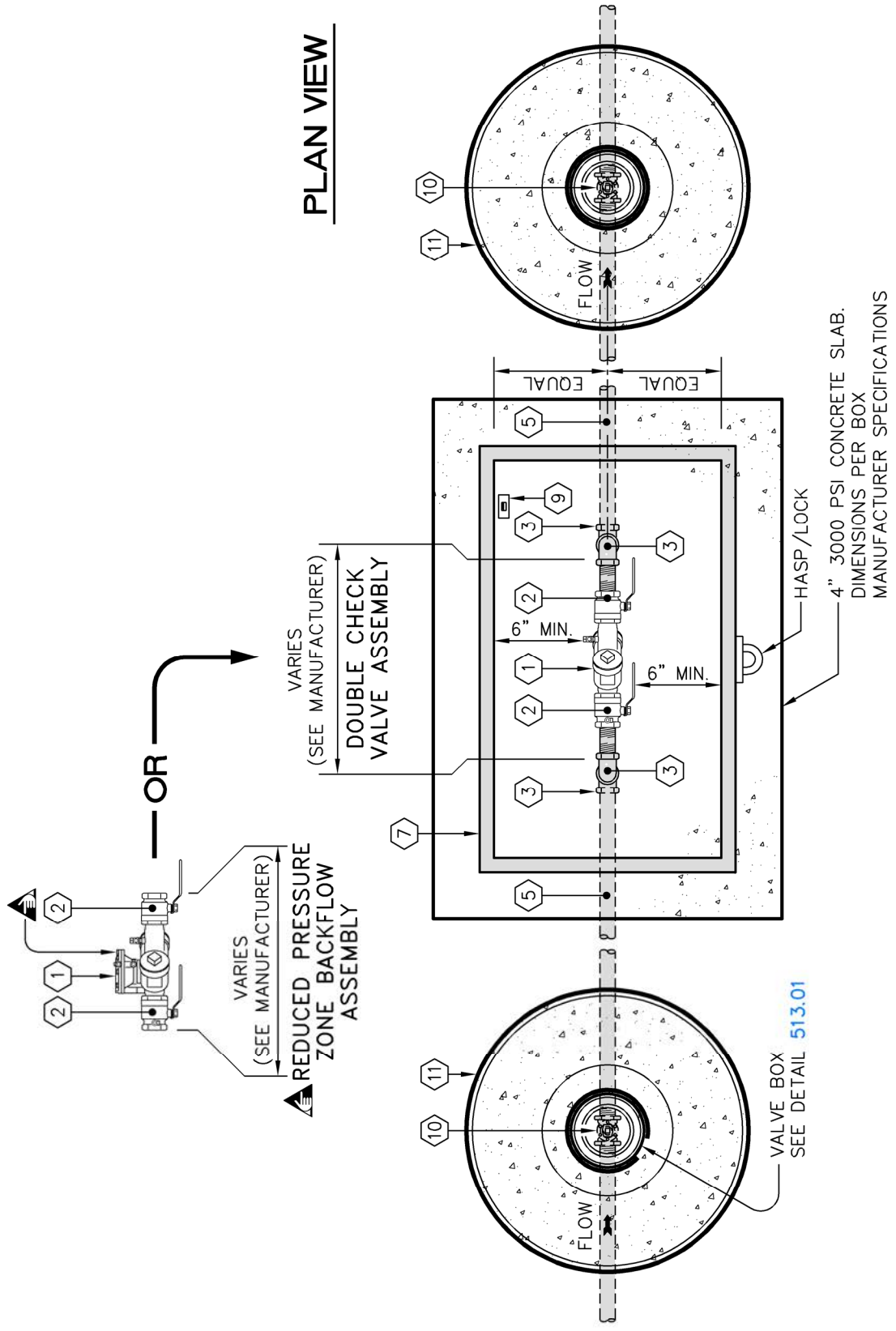
1. SEE SHEET 2 FOR PLAN VIEW.
2. SEE SHEET 3 FOR PART ID CHART AND TYPICAL ENCLOSURE.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" to 2" DCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE: Not To Scale	DETAIL # 2519.07
REVISION DATE: Oct., 2022	SHEET #: 1 of 3



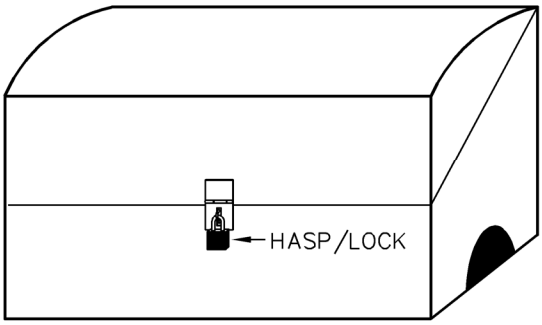
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" to 2" DCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE:	DETAIL #
Not To Scale	519.07
REVISION DATE:	SHEET #:
Oct., 2022	2 of 3

TYPICAL ENCLOSURE



⟨#⟩	PART	MANUFACTURER MODEL / Cat. No.
1	BACKFLOW PREVENTION ASSEMBLY, AS APPLICABLE	SEE SPECS. 02510 1.10 and 2.2.2 – PRODUCTS
2	1/4 TURN FULL PORT BRONZE BALL SHUT–OFF VALVE	---
3	90° BRASS ELBOW	---
4	THREADED UNION	---
5	3/4" THRU 2 1/2" STAINLESS STEEL OR BRASS THREADED PIPE	---
6	OMITTED	---
7	INSULATED ENCLOSURE WITH LOCKING ACCESS AND HEATER (120 V, 1 PHASE 60 HZ) VERIFY FITTINGS WILL FIT INSIDE BOX BEFORE ORDERING	HOTBOX / HB.75 – HB3E (OR APPROVED EQUIVALENT) (NOTE 3)
8	STAINLESS STEEL ANCHOR BOLTS PER BOX MANUFACTURER RECOMMENDED SIZE AND SPACING	---
9	PROVIDE 120V RECEPTACLE ON GFCI, SET MINIMUM 18" ABOVE FLOOR AND ABOVE DCV, RPZ. 6" CLEAR OF RISER	UL STD. 943–NEMA 3R.
10	THREADED IRON BODY GATE VALVE RESILIENT WEDGE	SEE PRE–APPROVED PRODUCTS LIST
11	PRECAST CONC. ROUND VALVE BOX PAD	SEE PRE–APPROVED PRODUCTS LIST SEE DETAIL 513.03

NOTES:

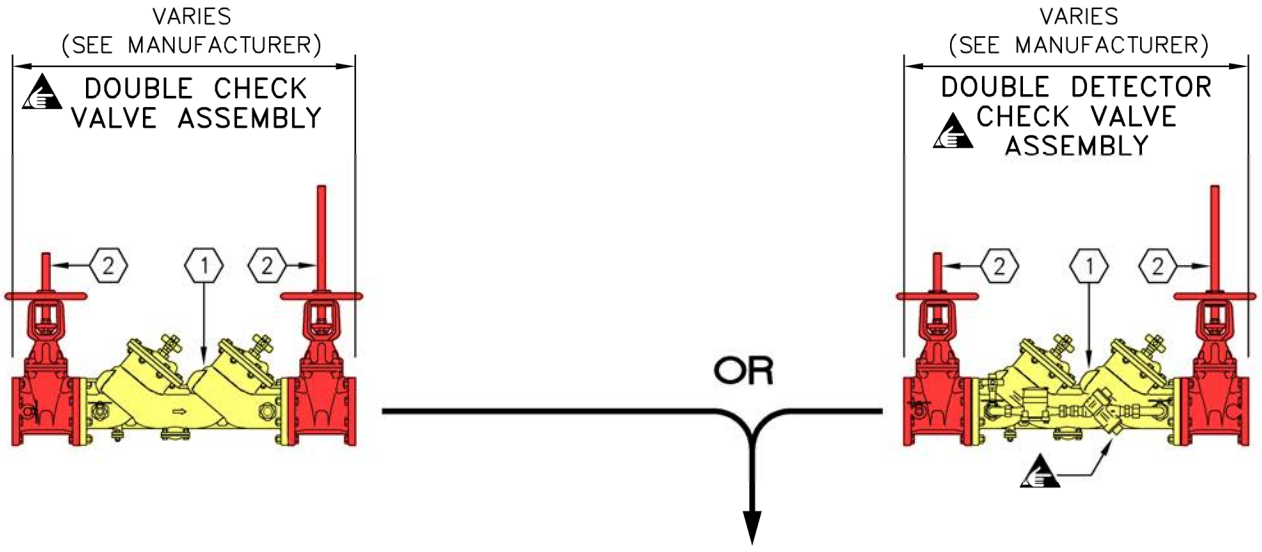
1. Provide minimum 1" annular clearance around all risers and electrical conduit.
2. Slope floor to drain to ports at both ends. Ensure positive surface grade away from enclosure.
3. Irrigation RPZ's that are removed from uninsulated & unheated enclosures to prevent freezing in the winter months must be capped off.
4. RPZ's may be located in building provided there are no other unprotected taps between the water main & the building.

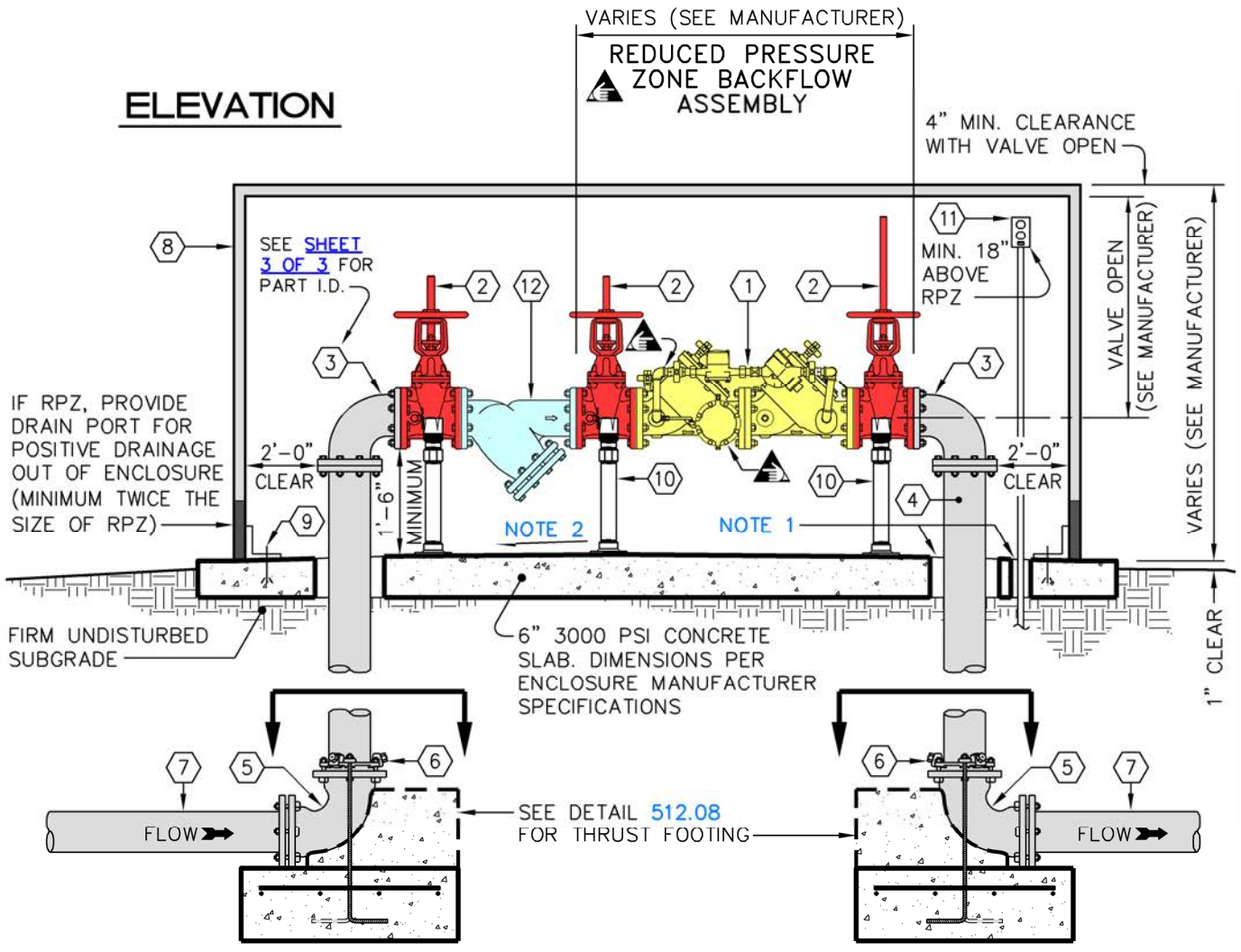
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" to 2" DCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE:	DETAIL #
Not To Scale	2519.07
REVISION DATE: Oct., 2022	SHEET #: 3 of 3



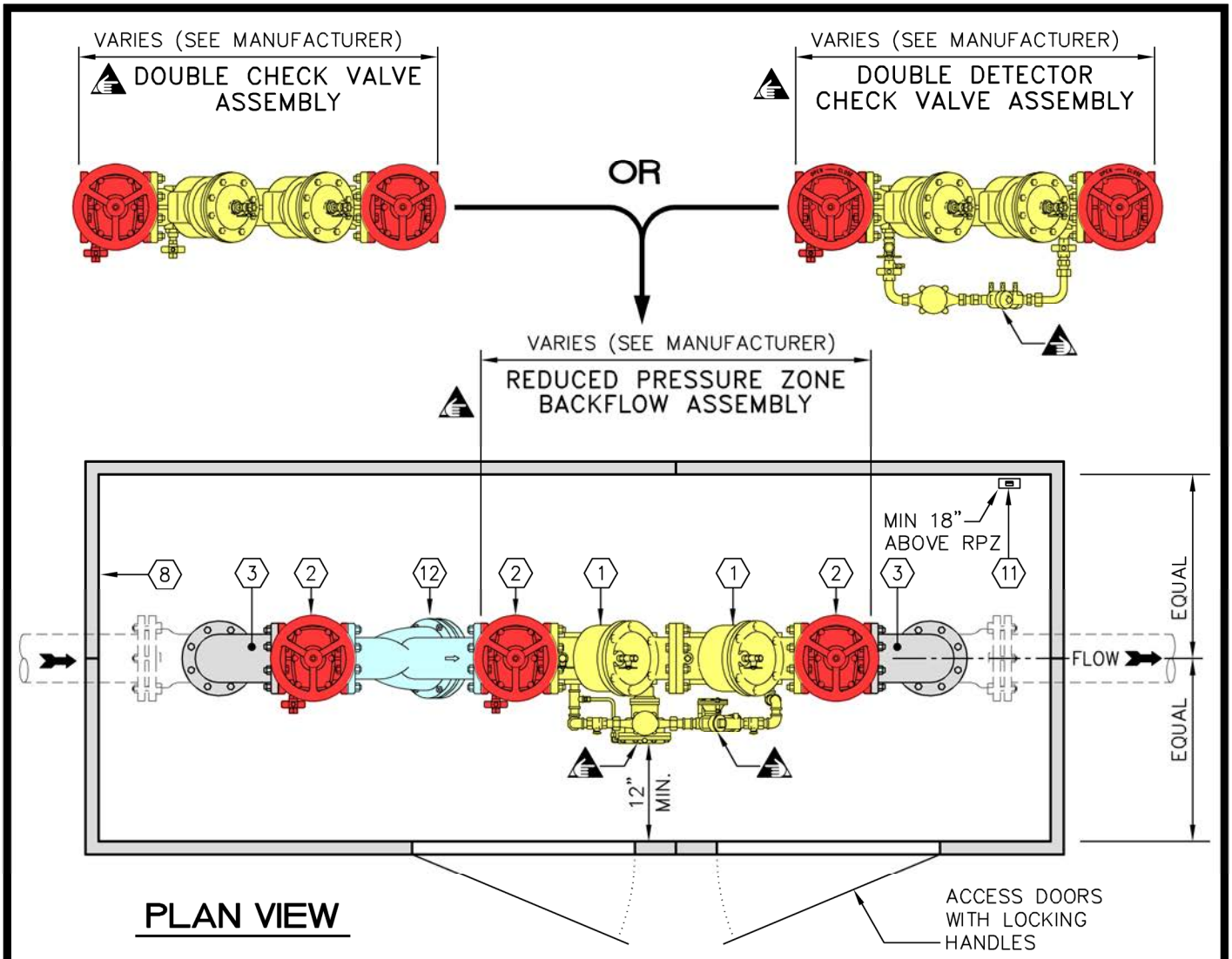


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

2 1/2" to 10" DCV, DDCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE:	DETAIL #
Not To Scale	2519.08
REVISION DATE:	SHEET #:
Oct., 2022	1 of 3



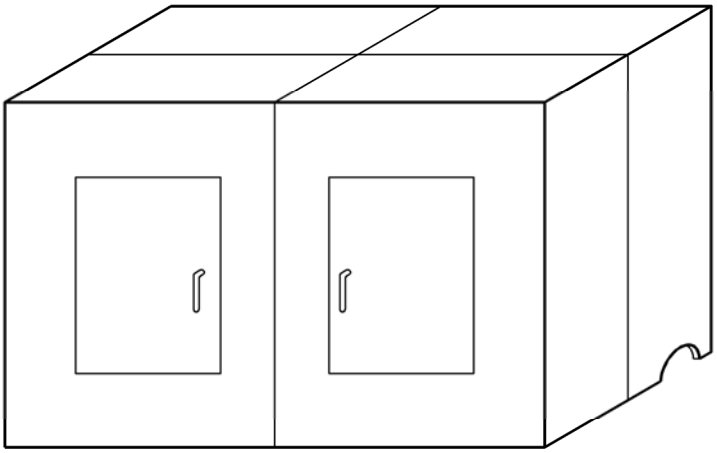
PLAN VIEW

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

2 1/2" to 10" DCV, DDCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE:	DETAIL #
Not To Scale	2519.08
REVISION DATE:	SHEET #:
Oct., 2022	2 of 3



TYPICAL BOX

(#)	PART	MANUFACTURER MODEL / Cat. No.
1	BACKFLOW ASSEMBLY	SEE SPECS. 02510 1.10 and 2.2.2 – PRODUCTS
2	OS&Y GATE VALVE WITH RESILIENT SEATS	SEE PRE-APPROVED PRODUCTS LIST
3	90° DIP FLANGE x FLANGE ELBOW	SEE PRE-APPROVED PRODUCTS LIST
4	DIP FLANGE x PE PIPE (VERIFY LENGTH)	SEE PRE-APPROVED PRODUCTS LIST
5	90° DIP MJ x MJ ELBOW	SEE PRE-APPROVED PRODUCTS LIST
6	WEDGE ACTION RESTRAINER GLAND JOINT RESTRAINT	SEE PRE-APPROVED PRODUCTS LIST
7	3" THRU 10" DIP	SEE PRE-APPROVED PRODUCTS LIST
8	INSULATED ENCLOSURE WITH LOCKING ACCESS DOORS AND HEATER (120 V, 1 PHASE, 60 HZ) VERIFY FITTINGS WILL FIT INSIDE BOX BEFORE ORDERING	INSULATED ENCLUSURE
9	STAINLESS STEEL EXPANSION ANCHOR BOLTS PER BOX MANUFACTURER RECOMMENDED SIZE & SPACING	---
10	ALUMINUM OR STAINLESS STEEL PIPE SUPPORTS.	SEE PRE-APPROVED PRODUCTS LIST
11	PROVIDE 120V RECEPTACLE ON GFCI, SET MINIMUM 12" ABOVE DISCHARGE POINT OF RPZ. (AS APPLICABLE)	UL STD. 943-NEMA 3R.
12	DIF FLG x FLG STRAINER	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES

NOTES:

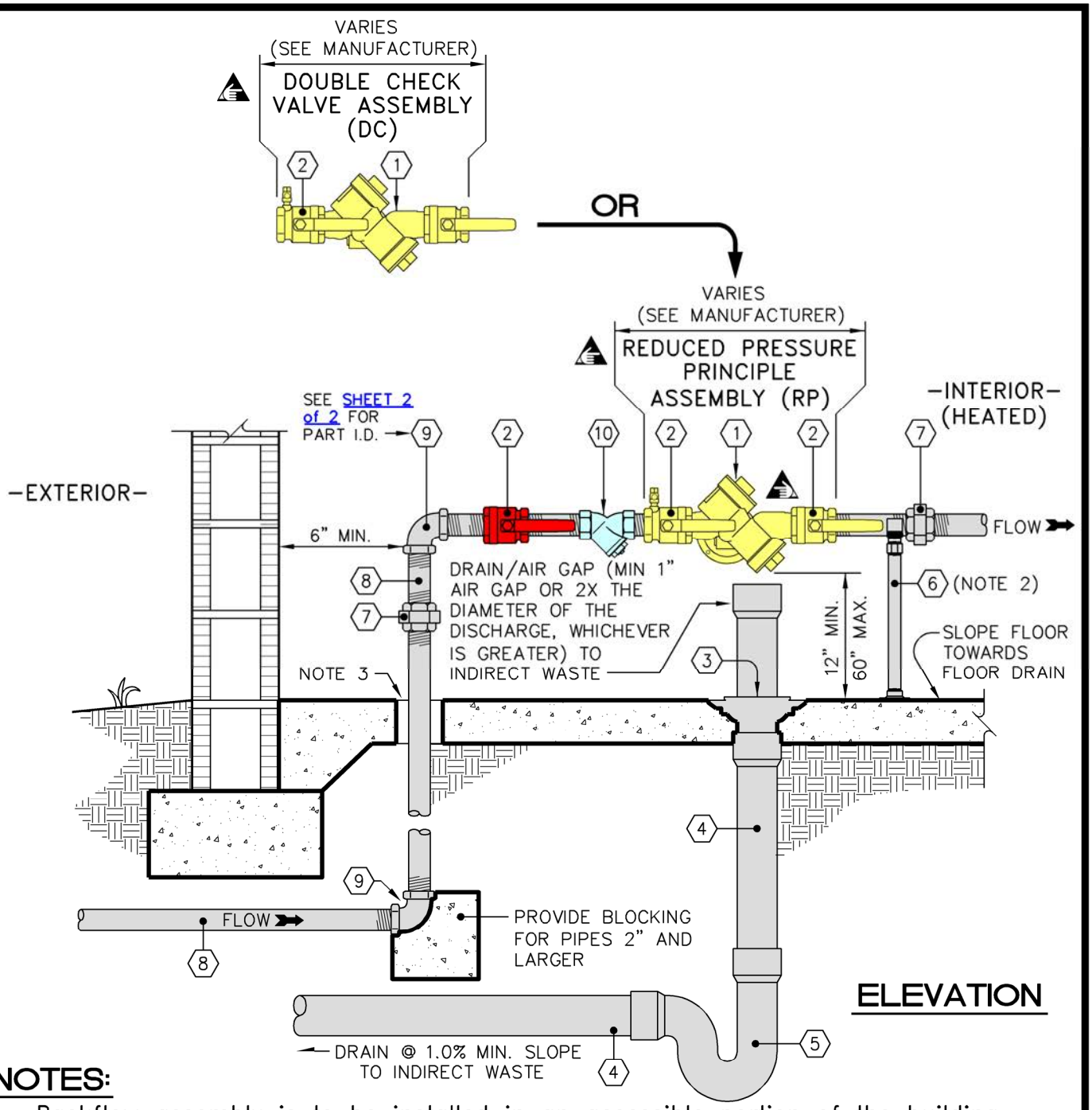
1. Provide minimum 3" annular clearance around all DIP risers and 1" around electrical conduit.
2. Slope floor to drain to ports at both ends. Ensure positive surface grade away from enclosure.
3. If Bypass installed, minimum clearance requirements still need to be met.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

2 1/2" to 10" DCV, DDCV, RPZ ASSEMBLY (ABOVE GROUND)

SCALE:	DETAIL #
Not To Scale	2519.08
REVISION DATE: Oct., 2022	SHEET #: 3 of 3



ELEVATION

NOTES:

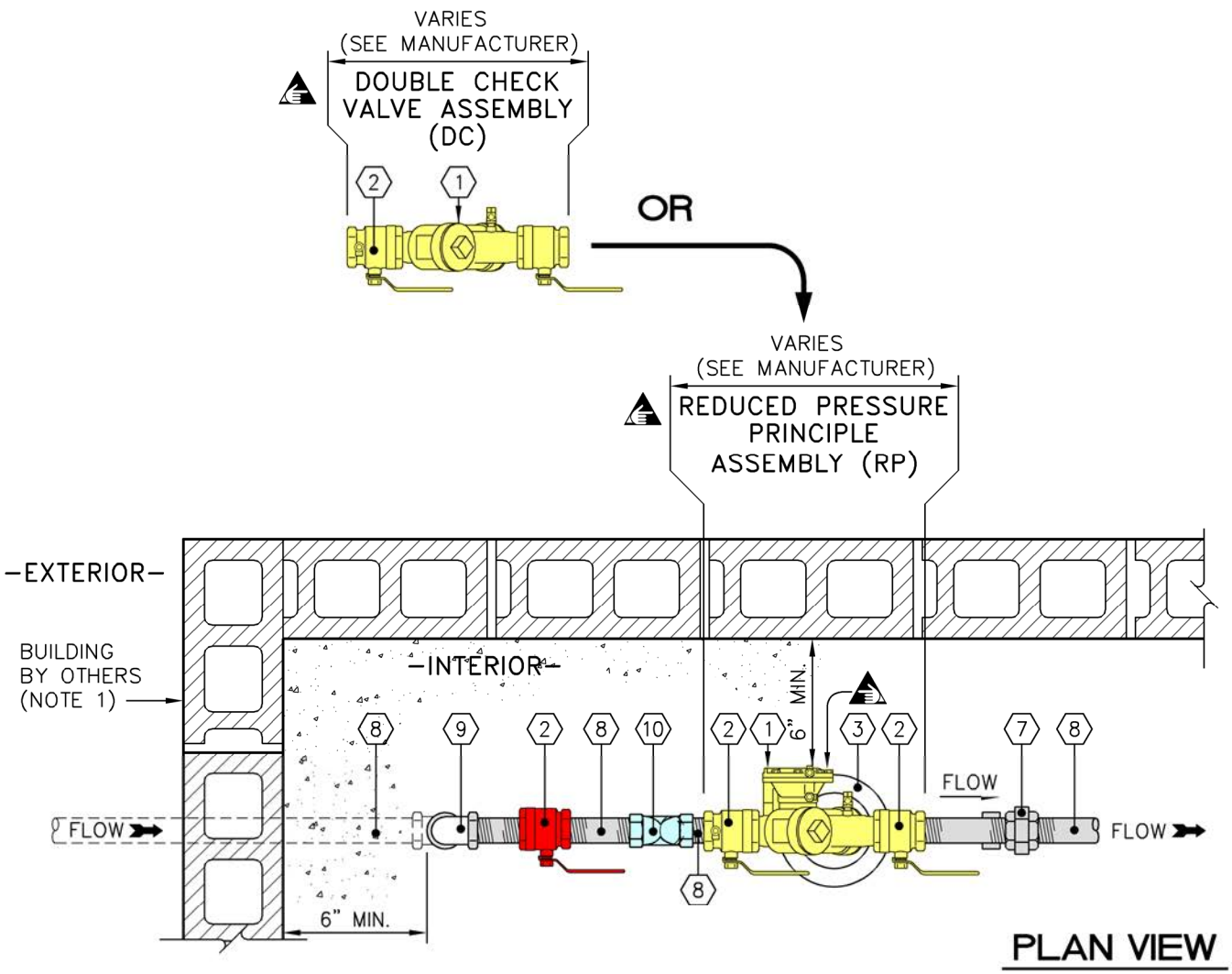
1. Backflow assembly is to be installed in an accessible portion of the building. Provide doorway & key.
2. Two pipe stands required for 1 1/2" and 2" backflow preventers.
3. Provide minimum 1" annular clearance around all risers and electrical conduit.
4. RPZ will release water.
5. Construction and materials to meet the requirements of the N.C. State Plumbing Code.
6. Minimum clearance 12" from ground, Maximum 60" to highest part of backflow & 6" clearance on all sides from walls.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" to 2" DOMESTIC DCV OR RPZ ASSEMBLY (INSIDE / HEATED)

SCALE:	DETAIL #
Not To Scale	2519.09
REVISION DATE:	SHEET #:
July, 2023	1 of 2



PLAN VIEW

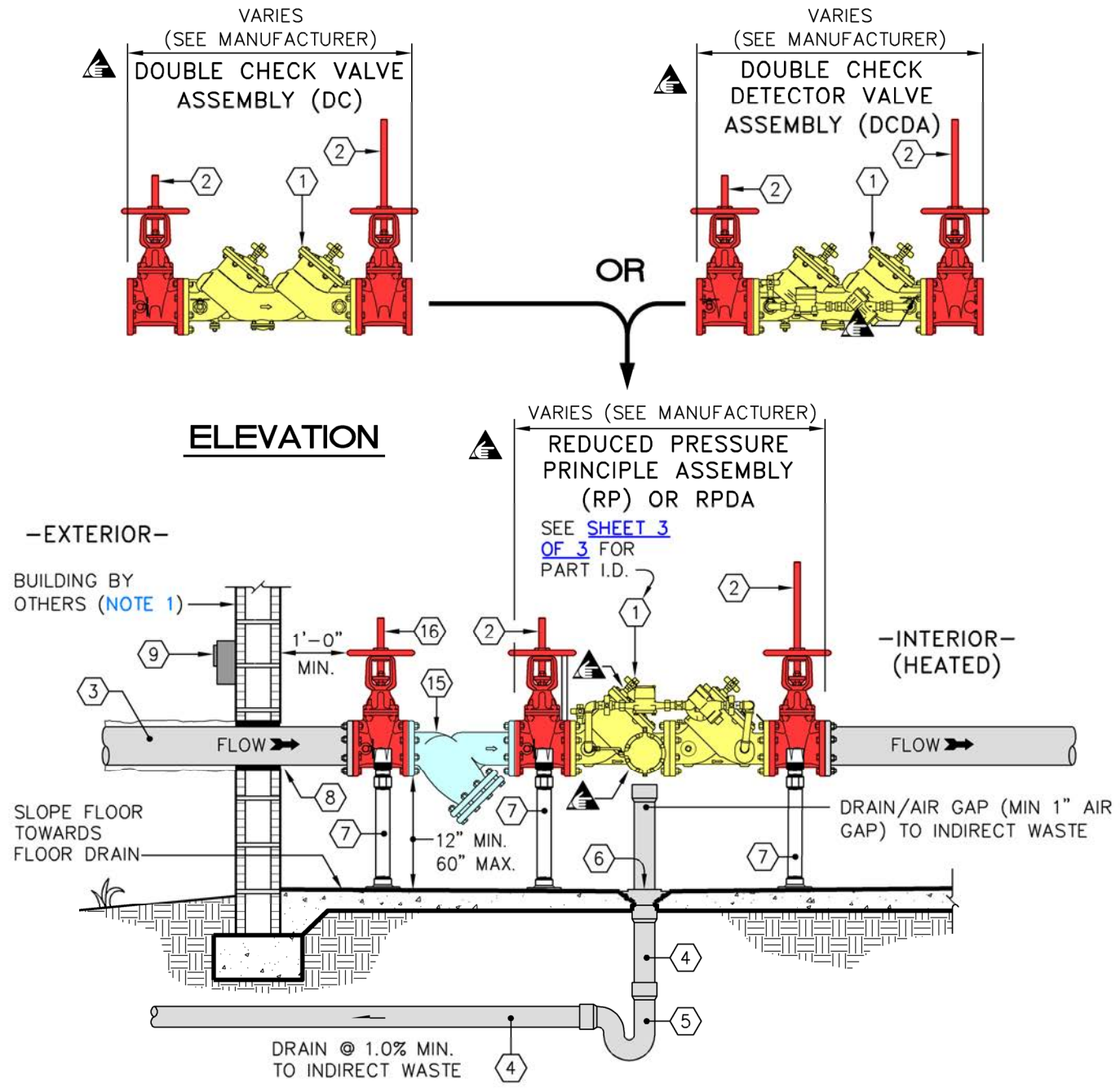
#	PART	MANUFACTURER MODEL / Cat. No.
1	BACKFLOW PREVENTION ASSEMBLY, AS APPLICABLE	ASSE APPROVED. SEE PRE–APPROVED PRODUCT LIST
2	1/4 TURN FULL PORT BRONZE BALL SHUT–OFF VALVE	---
3	FLOOR DRAIN OR AIR GAP DRAIN	JAY R. SMITH MFG. CO. / 2005
4	4" CISP OR PVC SCH 40 PIPE	---
5	4" CISP OR PVC SCH 40 P TRAP	---
6	ADJUSTABLE PIPE SUPPORTS SHALL BE ALUMINUM OR STAINLESS STEEL. SUPPORTS SHALL BE LOCATED WHERE THEY WILL NOT INTERFERE WITH CLEANING & MAINTENANCE OF THE BACKFLOW.	ADJUSTABLE PIPE (ALUMINUM OR STAINLESS STEEL)
7	OPTIONAL THREADED UNION (REQUIRED FOR IRRIGATION ONLY)	---
8	ALL MATERIALS TO CONFORM TO SECTION 605 OF NC PLUMBING CODE.	---
9	ALL MATERIALS TO CONFORM TO SECTION 605 OF NC PLUMBING CODE.	---
10	STRAINER REQUIRED W/I 3' OF BFP	---

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3/4" to 2" DOMESTIC DCV OR RPZ ASSEMBLY (INSIDE / HEATED)

SCALE:	DETAIL #
Not To Scale	2519.09
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



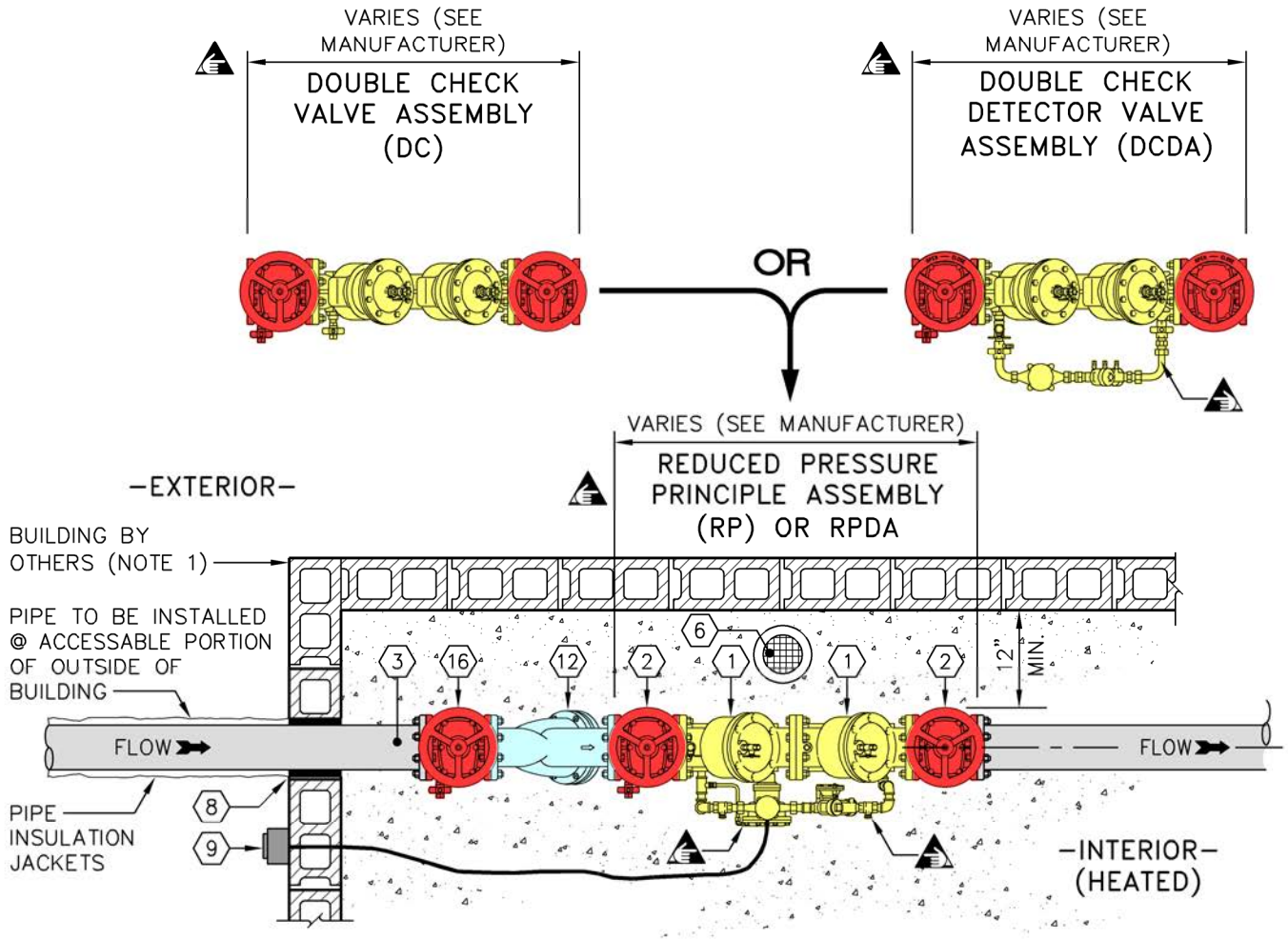
SEE SHEET 3 of 3 FOR ALTERNATE THRU FLOOR ACCESS INTO BUILDING

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" TO 12" DOMESTIC DC, DCDA, RP, RPDA ASSEMBLY (INDOOR)

SCALE:	DETAIL #
Not To Scale	2519.10
REVISION DATE:	SHEET #:
Oct., 2022	1 of 3



PLAN VIEW

NOTES:

1. Backflow assembly is to be installed at an accessible portion of outside of building, provide doorway & key.
2. For critical facilities, provide bypass line with equal degree of hazard backflow assembly.
3. Provide minimum 3" annular clearance around riser.
4. Minimum clearance 12" from ground, Maximum 60" to highest part of backflow & 6" clearance on all sides from walls.

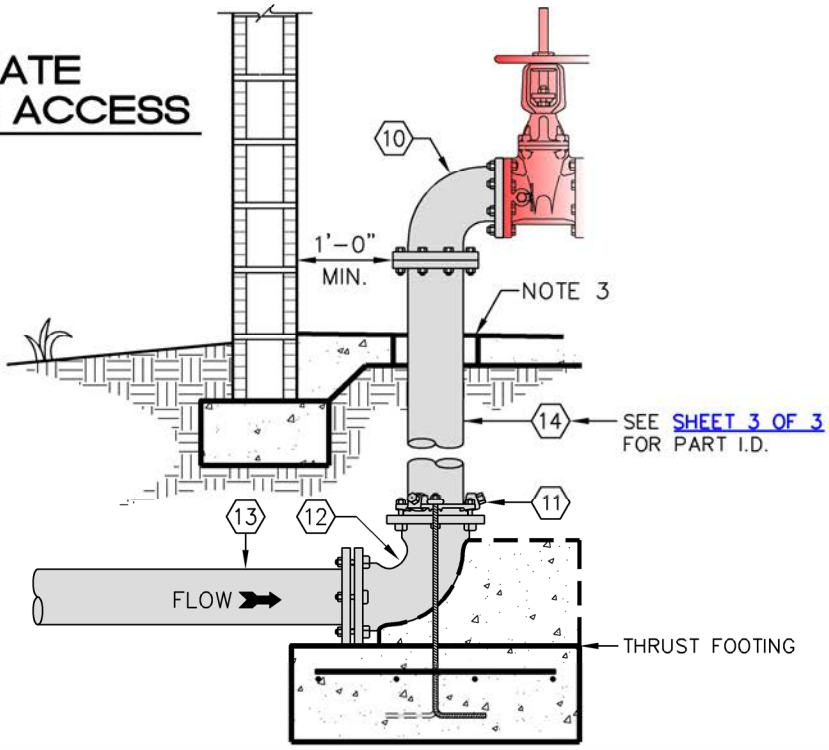
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" TO 12" DOMESTIC DC, DCDA, RP, RPDA ASSEMBLY (INDOOR)

SCALE: Not To Scale	DETAIL # 2519.10
REVISION DATE: Oct., 2022	SHEET #: 2 of 3

ALTERNATE THRU FLOOR ACCESS



(#)	PART	MANUFACTURER MODEL / Cat. No.
1	BACKFLOW PREVENTER, AS APPLICABLE	ASSE APPROVED, SEE PRE-APPROVED PRODUCTS LIST
2	OS&Y GATE VALVE WITH RESILIENT SEATS	ASSE APPROVED, SEE PRE-APPROVED PRODUCTS LIST
3	DIP FLANGE x FLANGE PIPE (VERIFY LENGTH). ALL MATERIALS TO CONFORM TO NC PLUMBING CODE.	SEE PRE-APPROVED PRODUCTS LIST
4	CISP OR PVC SCH 40 PIPE	---
5	CISP OR PVC SCH 40 "P" TRAP	---
6	FLOOR DRAIN	SIZE & TYPE DETERMINED BY NC PE. TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
7	ADJUSTABLE PIPE SUPPORTS SHALL BE ALUMINUM OR STAINLESS STEEL. SUPPORTS SHALL BE LOCATED WHERE THEY WILL NOT INTERFERE WITH CLEANING & MAINTENANCE OF THE BACKFLOW DEVICE.	SEE PRE-APPROVED PRODUCTS LIST
8	WALL SLEEVE with LINK SEAL	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
9	REMOTE METER READOUT (IN CUBIC FEET)	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
10	90° DIP FLANGE x FLANGE ELBOW	SEE PRE-APPROVED PRODUCTS LIST
11	WEDGE ACTION RESTRAINER GLAND JOINT RESTRAINT	SEE PRE-APPROVED PRODUCTS LIST
12	90° DIP MJ x MJ ELBOW	SEE PRE-APPROVED PRODUCTS LIST
13	DIP FLANGE x PE PIPE (VERIFY LENGTH)	SEE PRE-APPROVED PRODUCTS LIST
14	3" THRU 12" DIP. ALL MATERIALS TO CONFORM TO NC PLUMBING CODE.	SEE PRE-APPROVED PRODUCTS LIST
15	DIF FLG x FLG STRAINER	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
16	APPROVED SHUT-OFF-VALVE	TO CONFORM TO NC PLUMBING CODE.

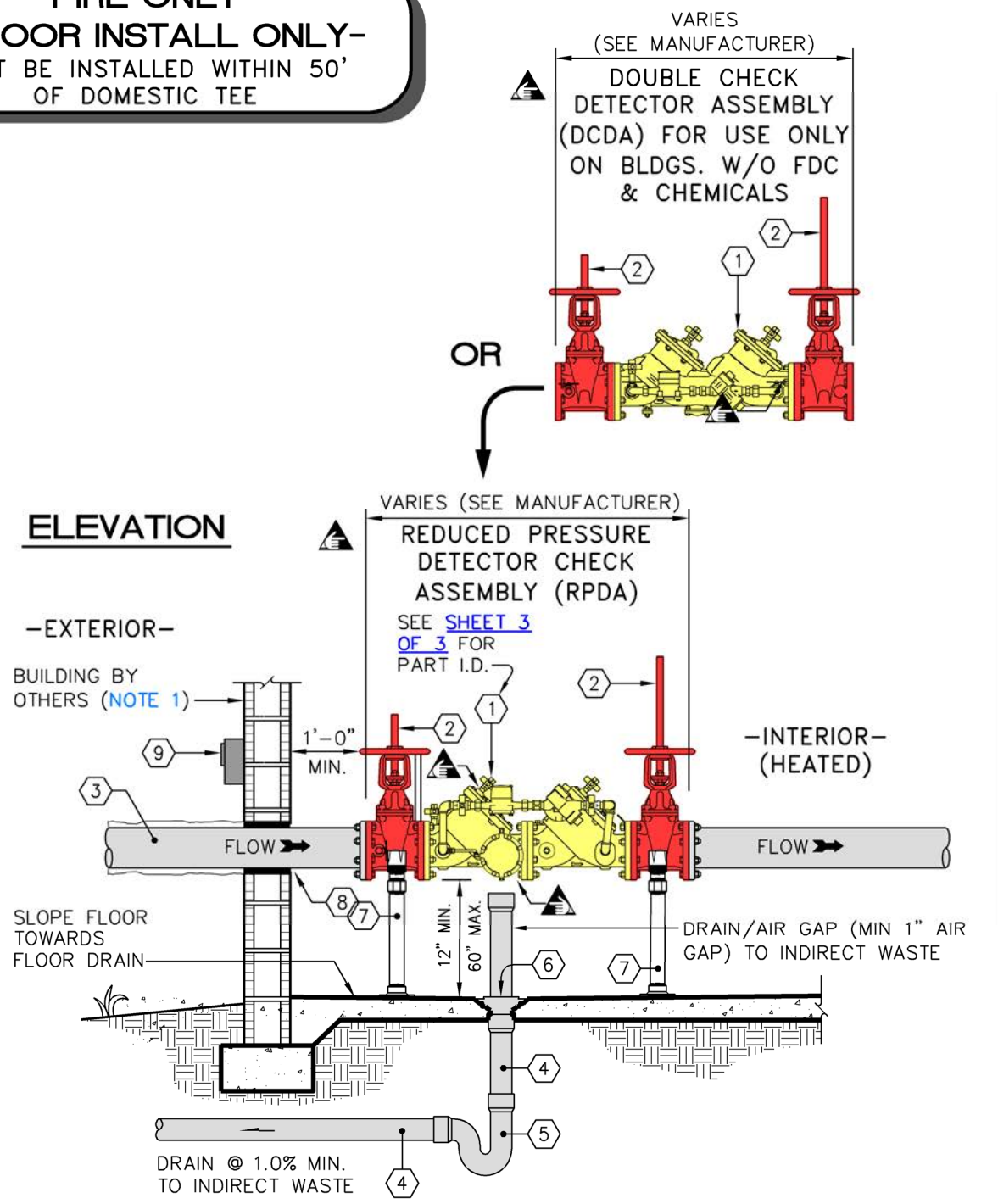
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" TO 12" DOMESTIC DC, DCDA, RP, RPDA ASSEMBLY (INDOOR)

SCALE:	DETAIL #
Not To Scale	2519.10
REVISION DATE: Oct., 2022	SHEET #: 3 of 3

-FIRE ONLY-
-INDOOR INSTALL ONLY-
MUST BE INSTALLED WITHIN 50' OF DOMESTIC TEE



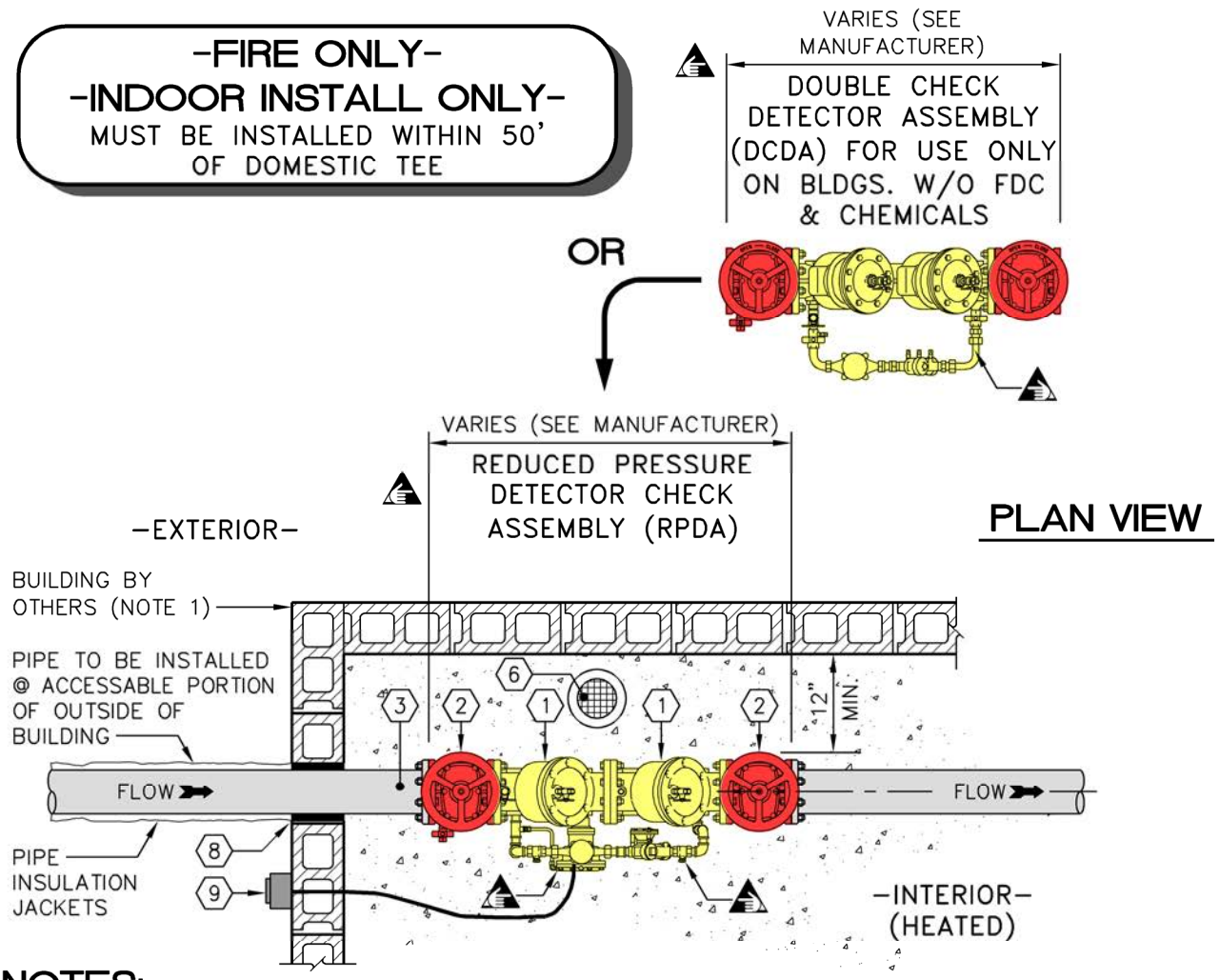
SEE SHEET 3 of 3 FOR ALTERNATE THRU FLOOR ACCESS INTO BUILDING

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" to 12" FIRE ONLY DDCV OR RPZ ASSEMBLY (INDOOR)

SCALE:	DETAIL #
Not To Scale	519.11
REVISION DATE: Oct., 2022	SHEET #: 1 of 3

-FIRE ONLY-
-INDOOR INSTALL ONLY-
MUST BE INSTALLED WITHIN 50' OF DOMESTIC TEE



NOTES:

1. Backflow assembly is to be installed at an accessible portion of the building, provide doorway & key.
2. For critical facilities, provide bypass line with equal degree of hazard backflow assembly.
3. Provide minimum 3" annular clearance around riser.
4. Minimum clearance 12" from ground, Maximum 60" to highest part of backflow & 6" clearance on all sides from walls.
5. For vertical applications, backflow preventers and bypass meters shall be ASSE approved for vertical application or the piping arranged to meet the requirements and limitations of the device/model proposed.
6. For piping arrangements that differ from this detail (horizontal application), the Fire Sprinkler Engineer shall submit a riser/piping diagram to the Town of Clayton for approval. Fire Sprinkler Engineer shall submit the proposed device manufacture and model number for verification that the device meets the Town of Clayton's Cross Connection Handbook; Guidelines and Requirements for the Cross Connection Program.
7. Fire mains to be pressure tested to 200 psi.
8. See also Detail 519.06 for exterior above ground application.

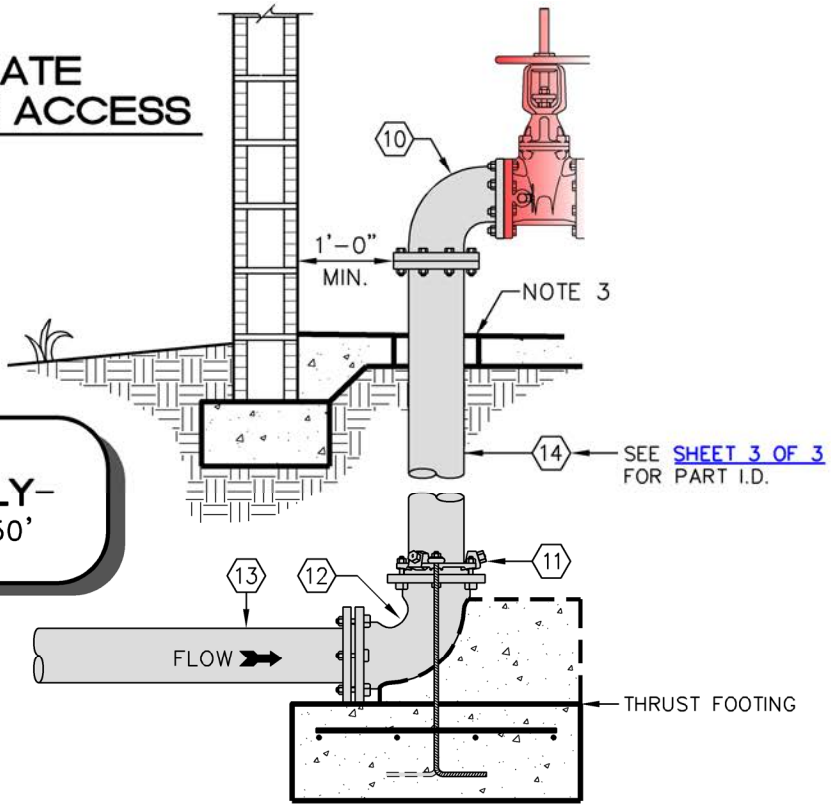
TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" to 12" FIRE ONLY DDCV OR RPZ ASSEMBLY (INDOOR)

SCALE:	DETAIL #
Not To Scale	519.11
REVISION DATE: Oct., 2022	SHEET #: 2 of 3

ALTERNATE THRU FLOOR ACCESS

-FIRE ONLY-
-INDOOR INSTALL ONLY-
MUST BE INSTALLED WITHIN 50' OF DOMESTIC TEE

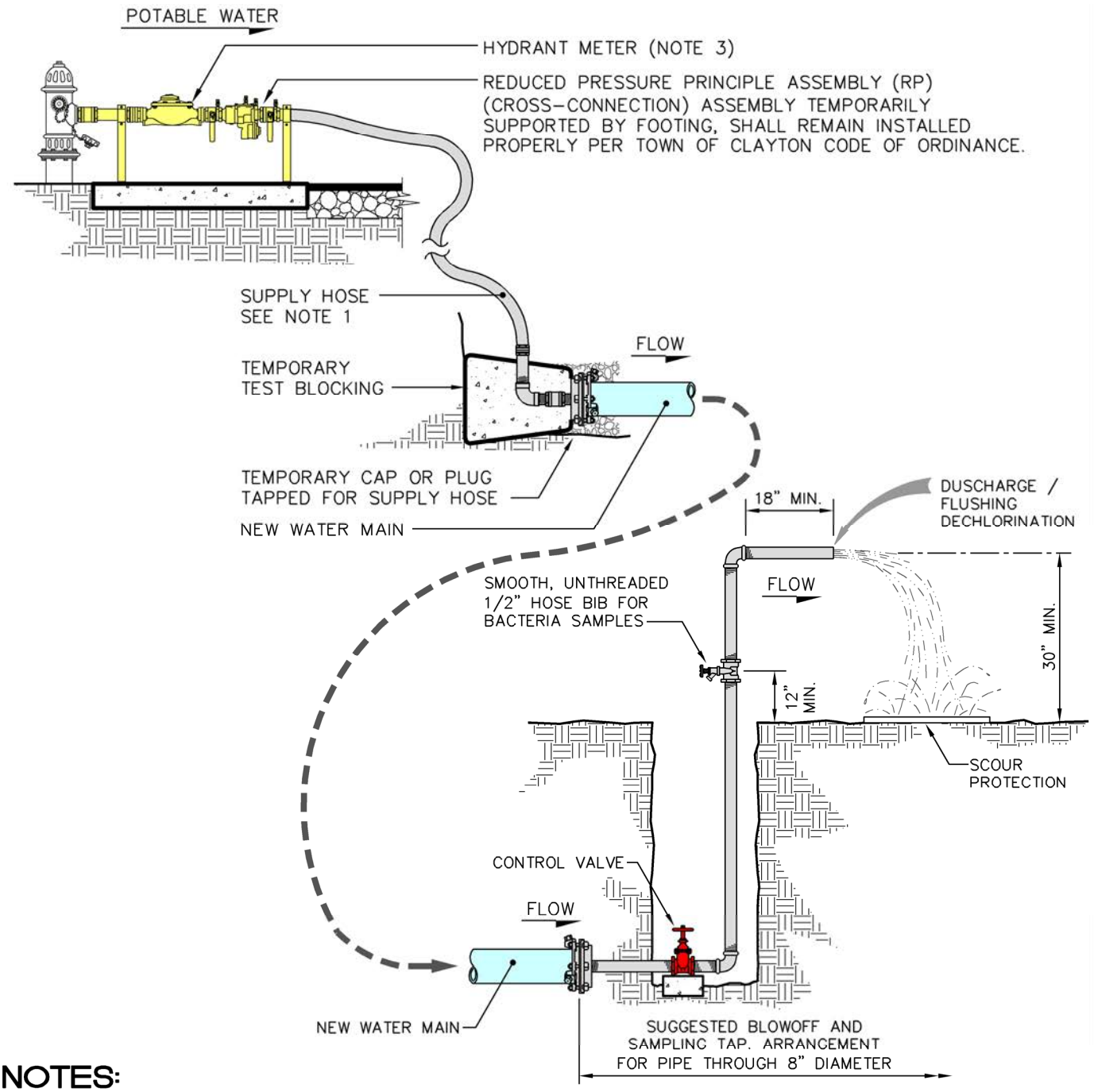


(#)	PART	MANUFACTURER MODEL / Cat. No.
1	BACKFLOW PREVENTER, AS APPLICABLE	ASSE APPROVED, SEE PRE-APPROVED PRODUCTS LIST
2	OS&Y GATE VALVE WITH RESILIENT SEATS	ASSE APPROVED, SEE PRE-APPROVED PRODUCTS LIST
3	DIP FLANGE x FLANGE PIPE (VERIFY LENGTH). ALL MATERIALS TO CONFORM TO NC PLUMBING CODE.	SEE PRE-APPROVED PRODUCTS LIST
4	CISP OR PVC SCH 40 PIPE	---
5	CISP OR PVC SCH 40 "P" TRAP	---
6	FLOOR DRAIN	SIZE & TYPE DETERMINED BY NC PE. TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
7	ADJUSTABLE PIPE SUPPORTS SHALL BE ALUMINUM OR STAINLESS STEEL. SUPPORTS SHALL BE LOCATED WHERE THEY WILL NOT INTERFERE WITH CLEANING & MAINTENANCE OF THE BACKFLOW.	SEE PRE-APPROVED PRODUCTS LIST
8	WALL SLEEVE with LINK SEAL	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
9	REMOTE METER READOUT (IN CUBIC FEET)	TO BE APPROVED BY TOWN OF CLAYTON WATER RESOURCES
10	90° DIP FLANGE x FLANGE ELBOW	SEE PRE-APPROVED PRODUCTS LIST
11	WEDGE ACTION RESTRAINER GLAND JOINT RESTRAINT	SEE PRE-APPROVED PRODUCTS LIST
12	90° DIP MJ x MJ ELBOW	SEE PRE-APPROVED PRODUCTS LIST
13	DIP FLANGE x PE PIPE (VERIFY LENGTH)	SEE PRE-APPROVED PRODUCTS LIST
14	3" THRU 12" DIP. ALL MATERIALS TO CONFORM TO NC PLUMBING CODE.	SEE PRE-APPROVED PRODUCTS LIST

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

3" to 12" FIRE ONLY DDCV OR RPZ ASSEMBLY (INDOOR)

SCALE:	DETAIL #
Not To Scale	2519.11
REVISION DATE: Oct., 2022	SHEET #: 3 of 3



NOTES:

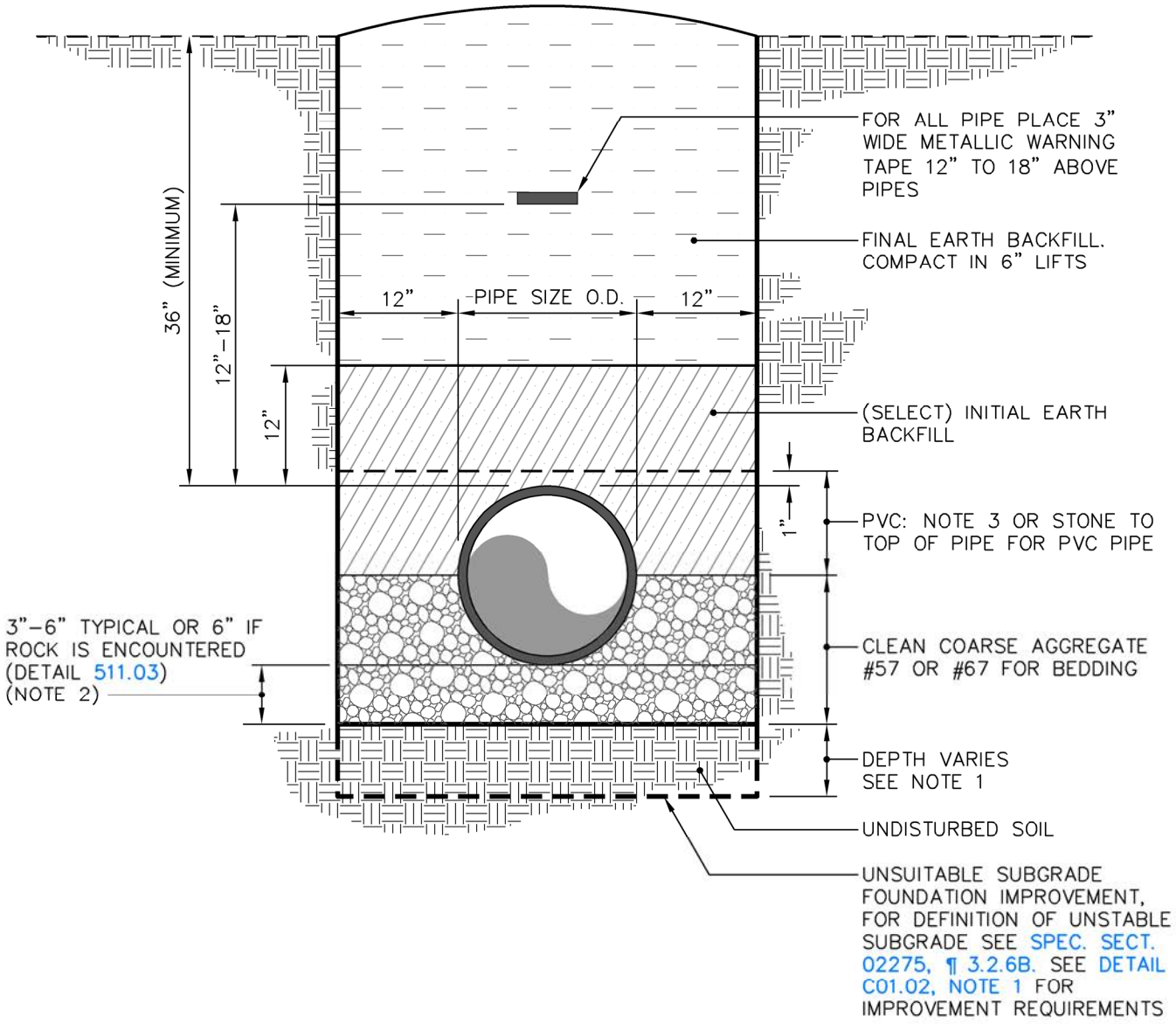
1. Clean potable-water hose only. Size and number of taps per TABLE 3 of AWWA C651. This hose must be removed during the hydrostatic pressure test
2. This detail applies to pipes with diameters 4 inch through 12 inches. Larger sizes must be handled on a case-by-case basis and approved by the Town of Clayton Water Resources.
3. Hydrant Meter available from the Town of Clayton Water Resources in accordance with policy.
4. No backflow permit is required for these. A passing backflow test must be performed within 12 months. See Cross-Connection Ordinance.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SUGGESTED TEMPORARY FLUSHING / TESTING CONNECTION

SCALE:	DETAIL #
Not To Scale	2519.20
REVISION DATE:	SHEET #:
Oct., 2022	1 of 1



NOTES:

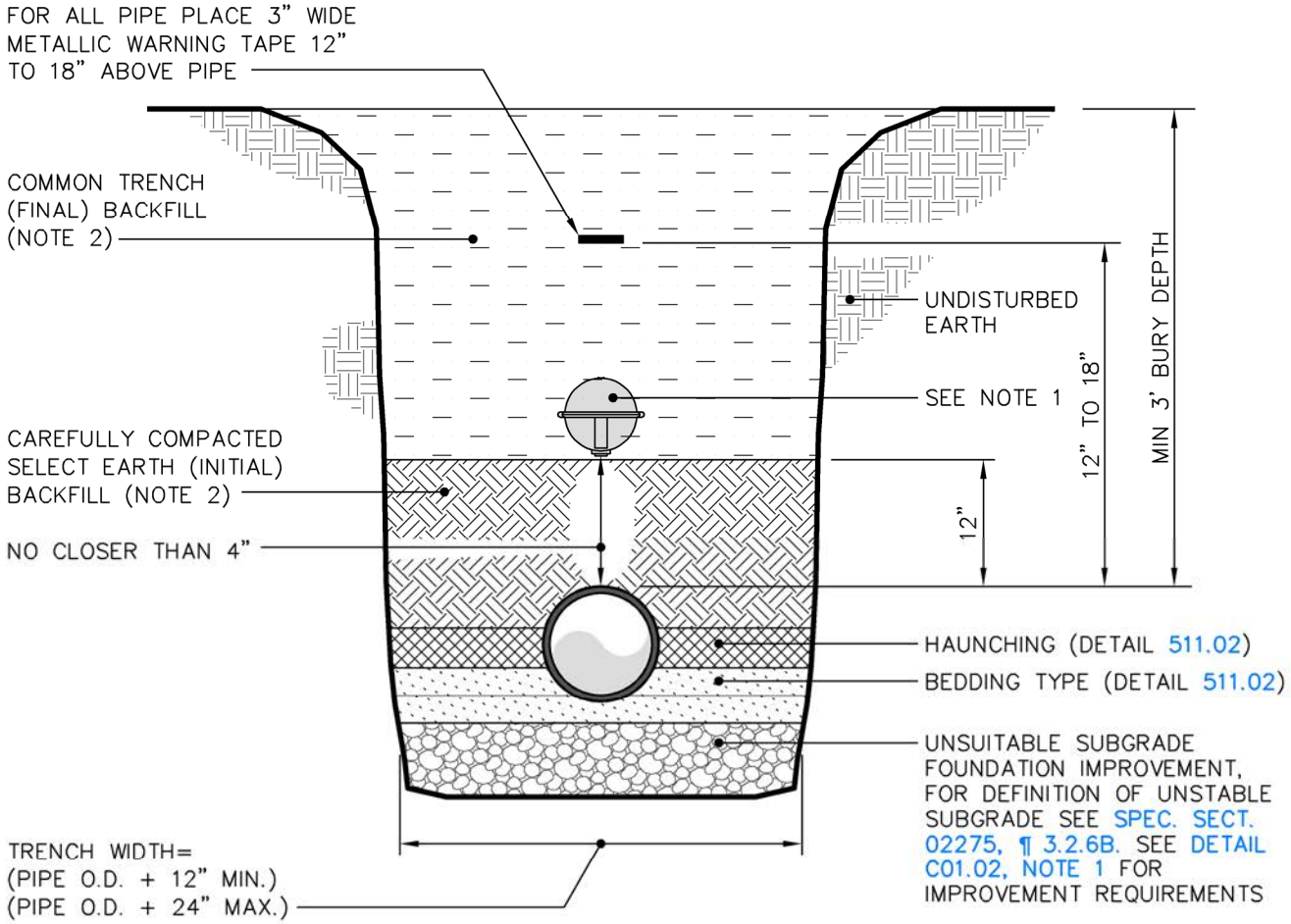
1. Foundation stone shall be required when soil conditions are unsuitable. See detail C01.02.
2. An additional 1 inch depth of bedding material will be required for each additional 2 feet of trench depth in excess of 16 feet up to a maximum of 12 inches.
3. Haunching depth for flexible wall pipe (C900 PVC and SDR35) shall be outside pipe diameter + 1 inch. Haunching shall be thoroughly compacted #57 or #67 stone.
4. Where rock is encountered, refer to detail 511.03 for subgrade preparation.
5. For all force mains, embedment to be Type 1 or 2 as shown on detail 511.02.
6. See also detail 531.03.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SANITARY SEWER GRAVITY PIPE LAYING CONDITIONS

SCALE:	DETAIL #
Not To Scale	531.01
REVISION DATE:	SHEET #:
Oct., 2022	1 of 1



NOTES:

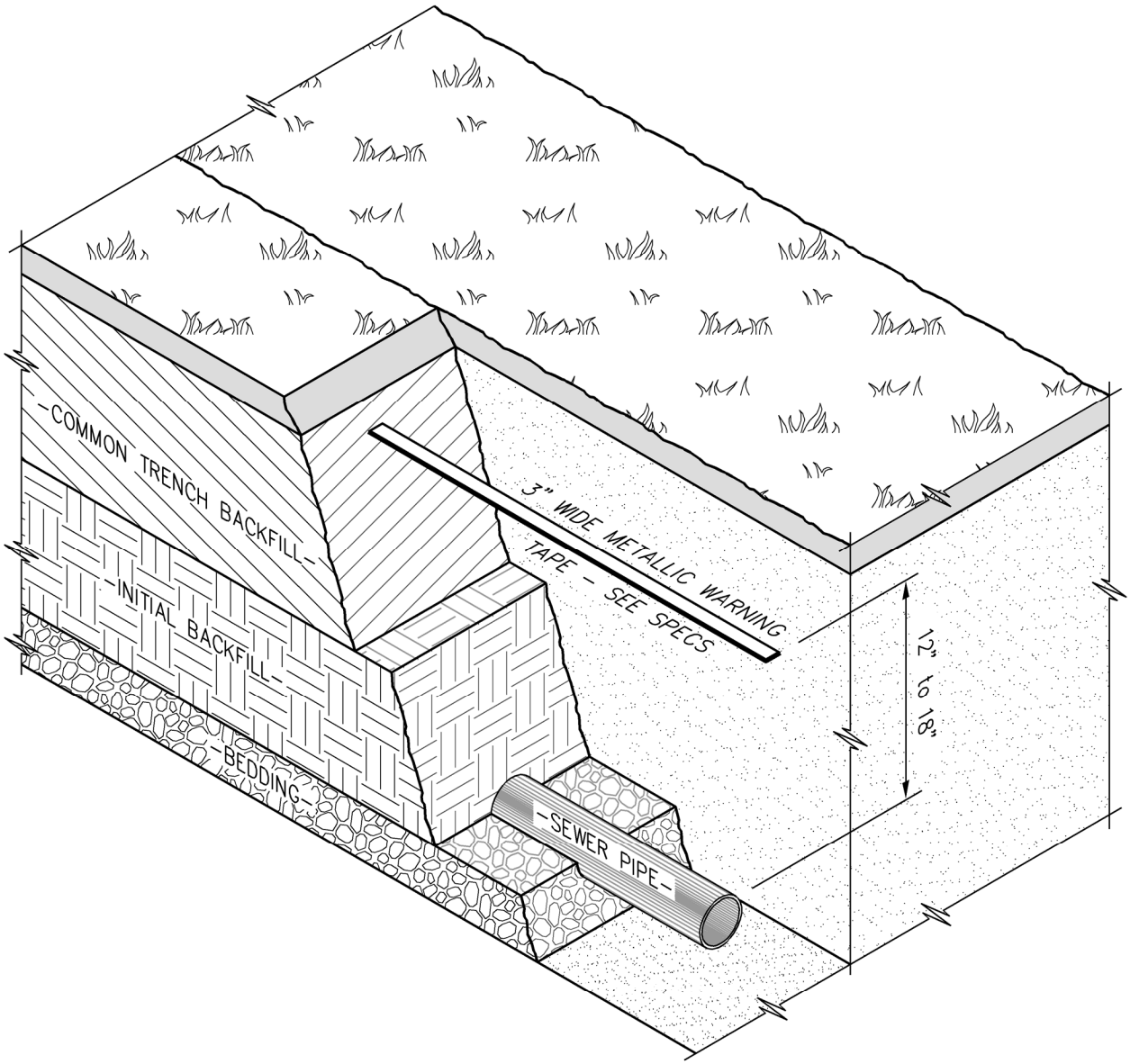
1. See Detail C01.04 for RFID ball marker location requirements.
2. See specifications Section 02275, Part 2 – PRODUCTS for composition of Select Earth Backfill and Common Trench Backfill.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

SEWER FORCE MAIN PIPE LAYING CONDITIONS

SCALE:	DETAIL #
Not To Scale	2 531.02
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

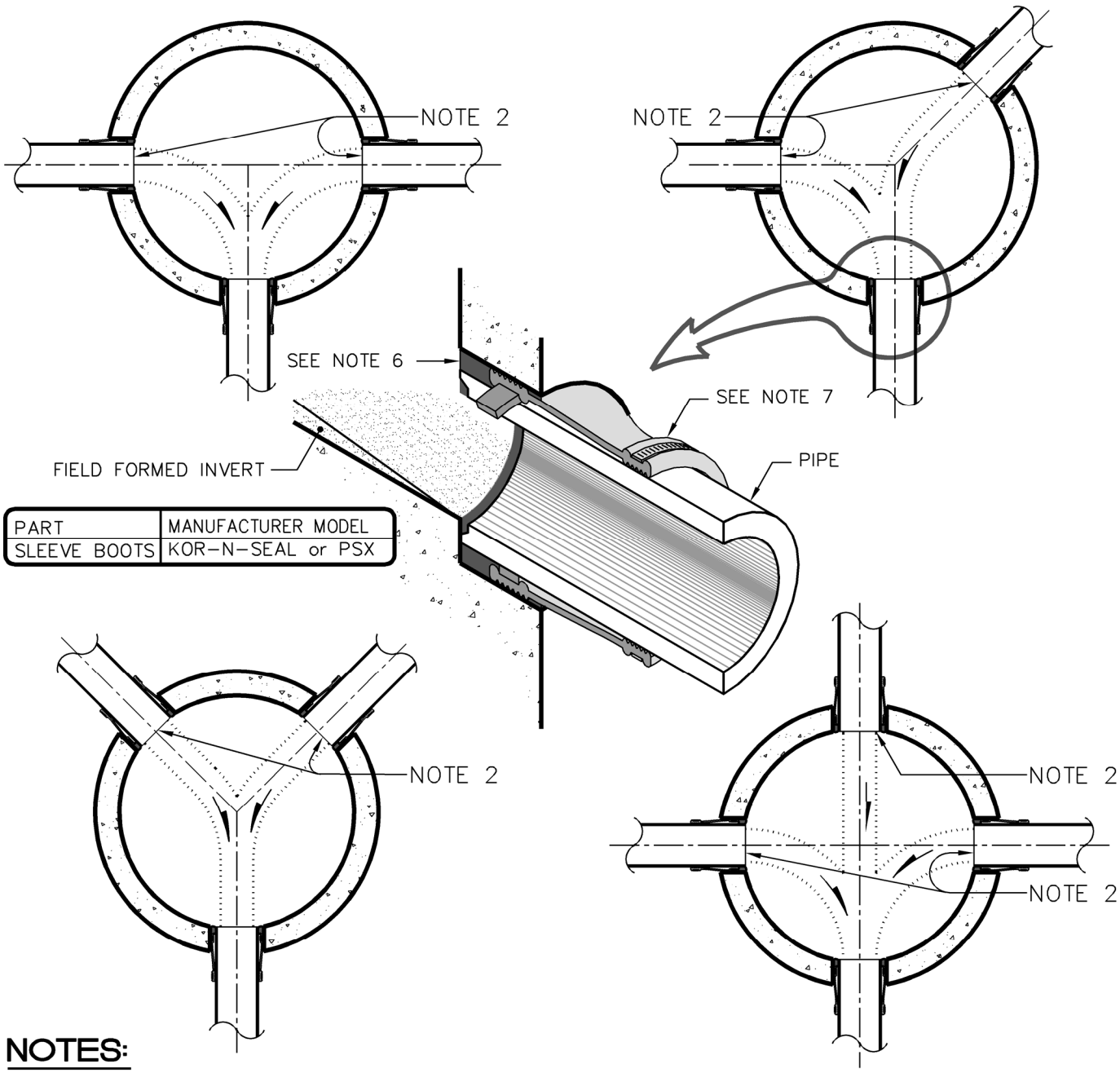
1. See Detail 531.01 and, where applicable as shown on Detail C01.04, for RFID marker ball location guide.
2. See pre-approved product list for approved products.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

METALLIC WARNING TAPE PLACEMENT

SCALE:	DETAIL #
Not To Scale	2 531.03
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



PART	MANUFACTURER MODEL
SLEEVE BOOTS	KOR–N–SEAL or PSX

NOTES:

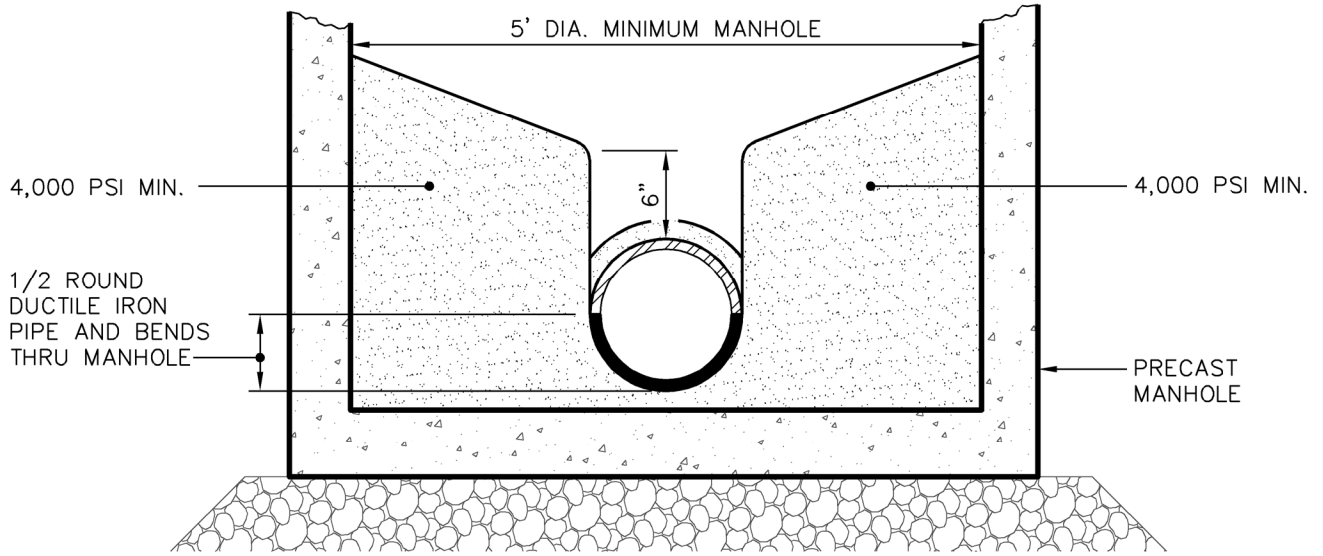
1. Concrete shelf should be no lower than the pipe spring line elevation at manhole wall.
2. Service line entries to have cast in place troughs.
3. Radius of invert must have enough room to be able to insert air plugs and TV equipment.
4. Concrete strength to be 3,000 PSI minimum.
5. Concrete formed invert shall be precast wherever possible. Moorbase not permitted.
6. Pipes will be grouted inside.
7. Flexible sleeve boots cast in place or installed with stainless steel expander rings as manufactured by Kor–N–Seal or PSX shall be used for pipe connections. Boots shall be secured to pipe using (2) stainless steel bands.

TOWN of CLAYTON

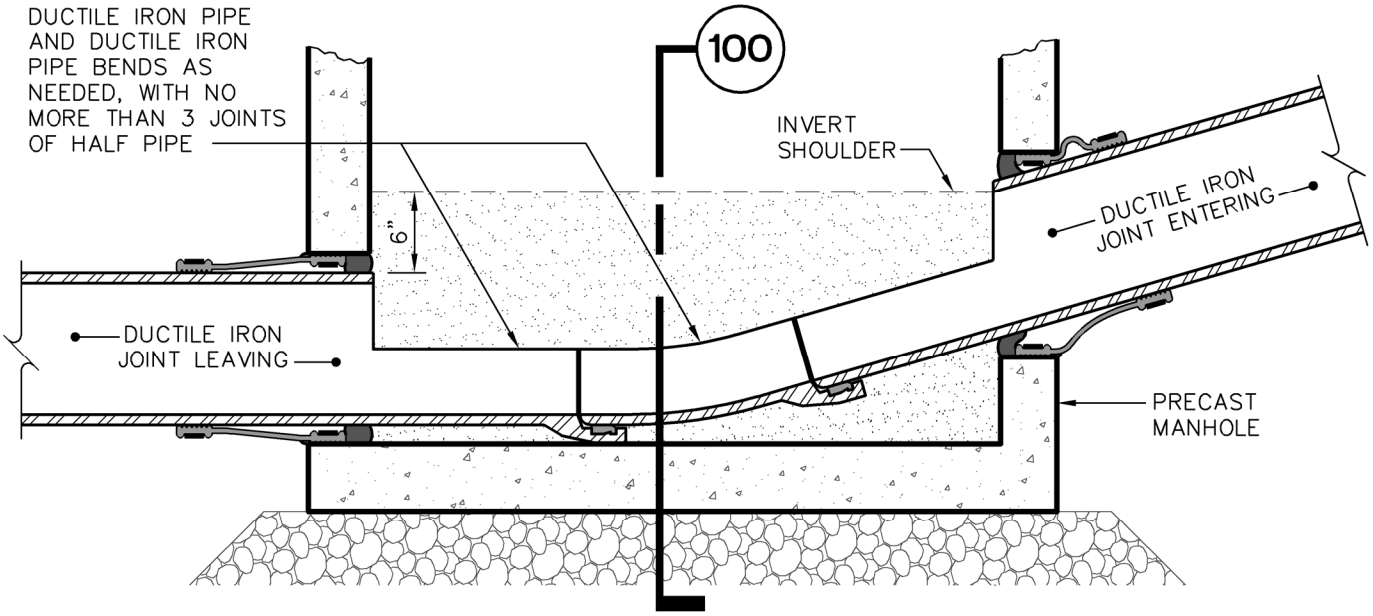
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL SEWER INVERT PLANS FOR MANHOLES

SCALE:	DETAIL #
Not To Scale	2532.01
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



100 TRAVERSE SECTION AT HALF PIPE INVERT



LONGITUDINAL SECTION ALONG CENTERLINE OF SEWER PIPE

NOTES:

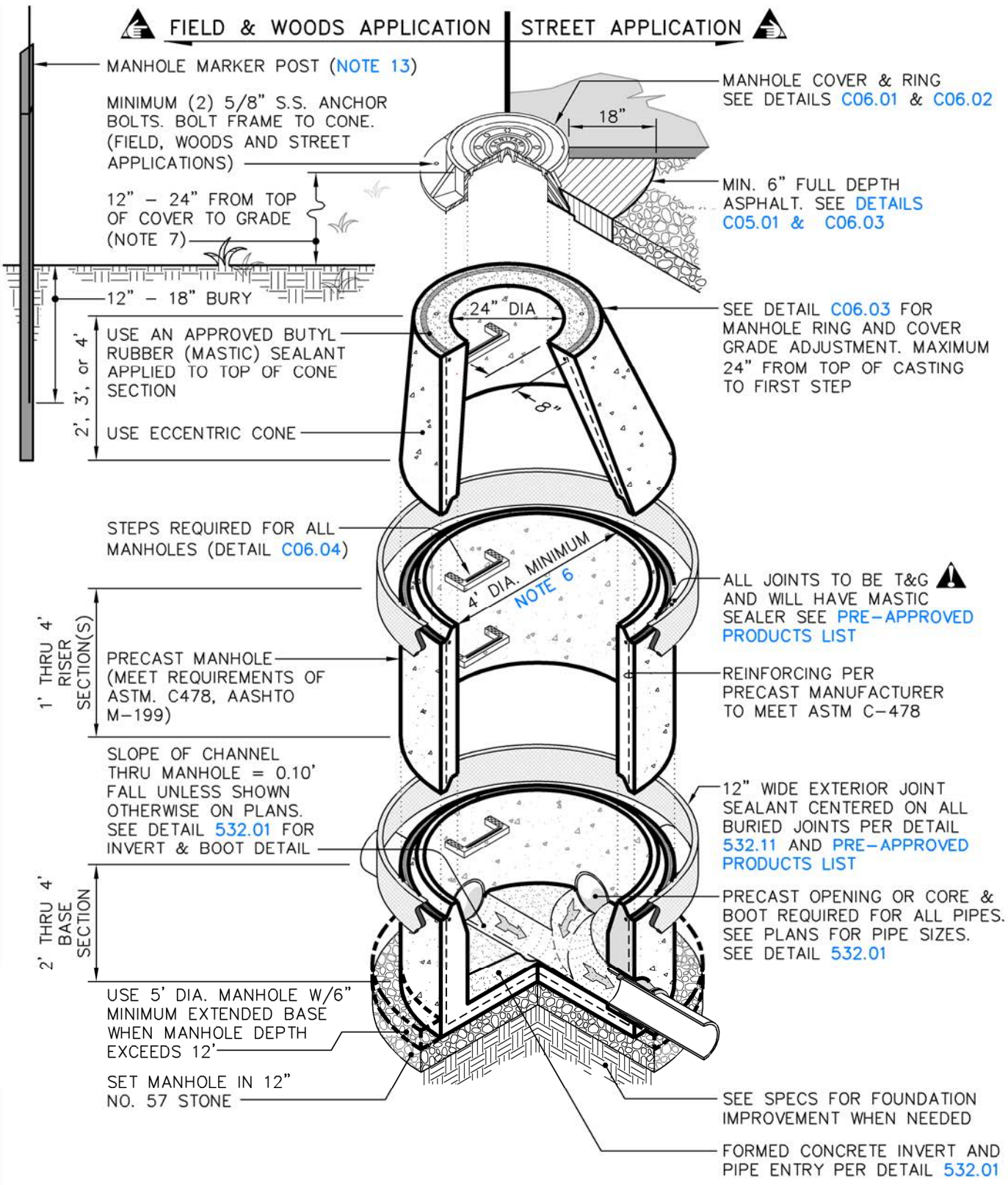
1. No horizontal alignment change can be made with this manhole type. Use on DIP pipe grades 10% or greater.
2. Concrete strength to be 4,000 PSI minimum.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

HIGH VELOCITY INVERT DETAIL

SCALE:	DETAIL #
Not To Scale	2 532.02
REVISION DATE: Oct., 2022	SHEET #: 1 of 1

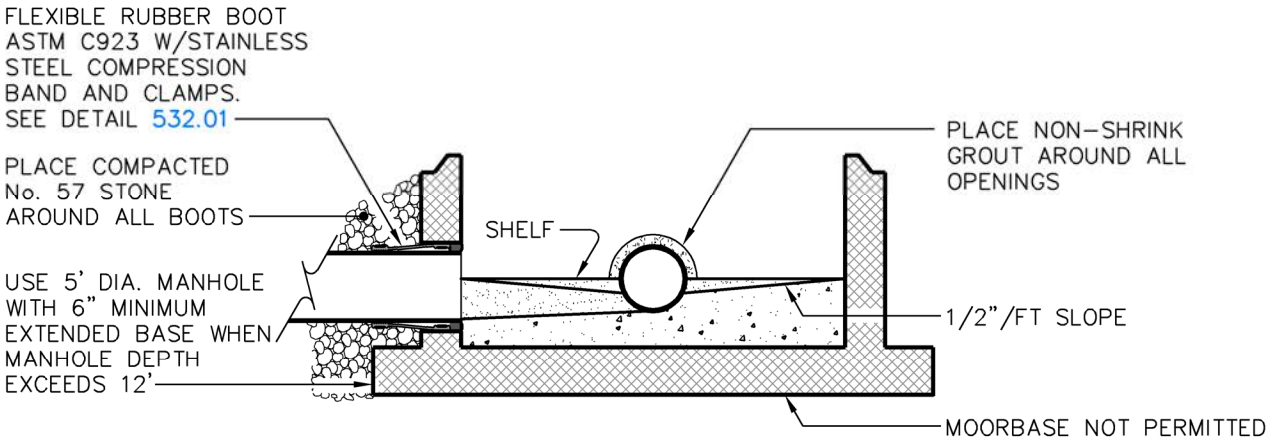


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD ECCENTRIC PRECAST MANHOLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 532.03
REVISION DATE: Oct., 2022	SHEET #: 1 of 2



NOTES:

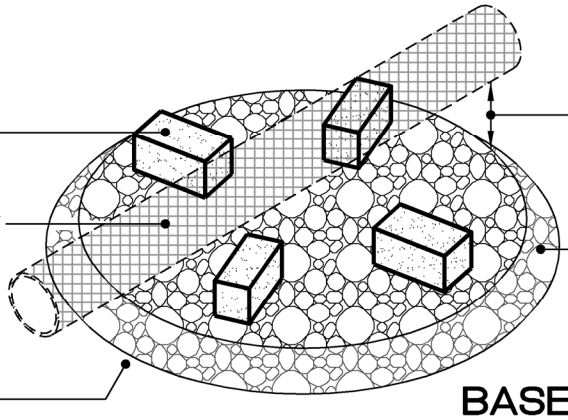
1. Concrete strength to be 3,000 PSI minimum.
2. Pipes will be grouted inside.
3. Flexible sleeve boots cast in place or installed with stainless steel expander rings. Boots to meet ASTM C-923 standards.
4. See detail 532.01 for typical invert shaping.
5. Service laterals into existing manholes to be core drilled and booted.
6. Maximum depth 4' diameter manhole = 12' (see sewer design section for other requirements / limitations).
7. If height above grade exceeds 24", use eccentric flat top.
8. For watertight applications, place butyl rubber between frame and cone with water tight ring & cover.
9. For pipe connections 12" and larger, 2 sets of bands shall be required.
10. Lubricate the following: Pipe exterior, boot interior, boot exterior, S.S. bands (Top & bottom)
11. Place manhole opening over the effluent line.
12. Manholes subject to flooding shall have the top of the manhole rim a minimum of 12" above the 100 Yr. BFE or vented every 3rd manhole, but not exceeding 1,000 LF between vents. Vents shall be placed a minimum of 12" above the 100 Yr. BFE. See detail 532.10.
13. Manhole marker post to be supplied and installed by contractor over sewer line located outside of pavement.
14. See pre-approved products list for approved products.
15. Do not place grout at manhole section joints.

TOWN of CLAYTON

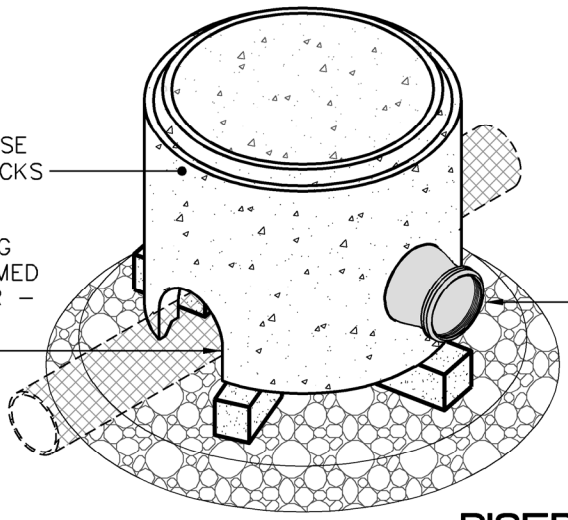
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD ECCENTRIC PRECAST MANHOLE DETAIL

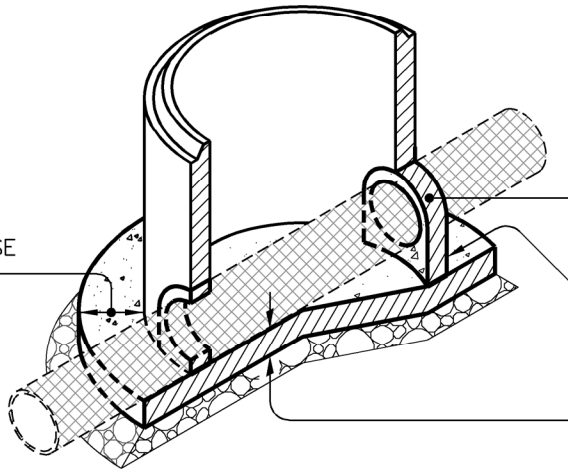
SCALE:	DETAIL #
Not To Scale	2 532.03
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



BASE ISOMETRIC VIEW



RISER ISOMETRIC VIEW



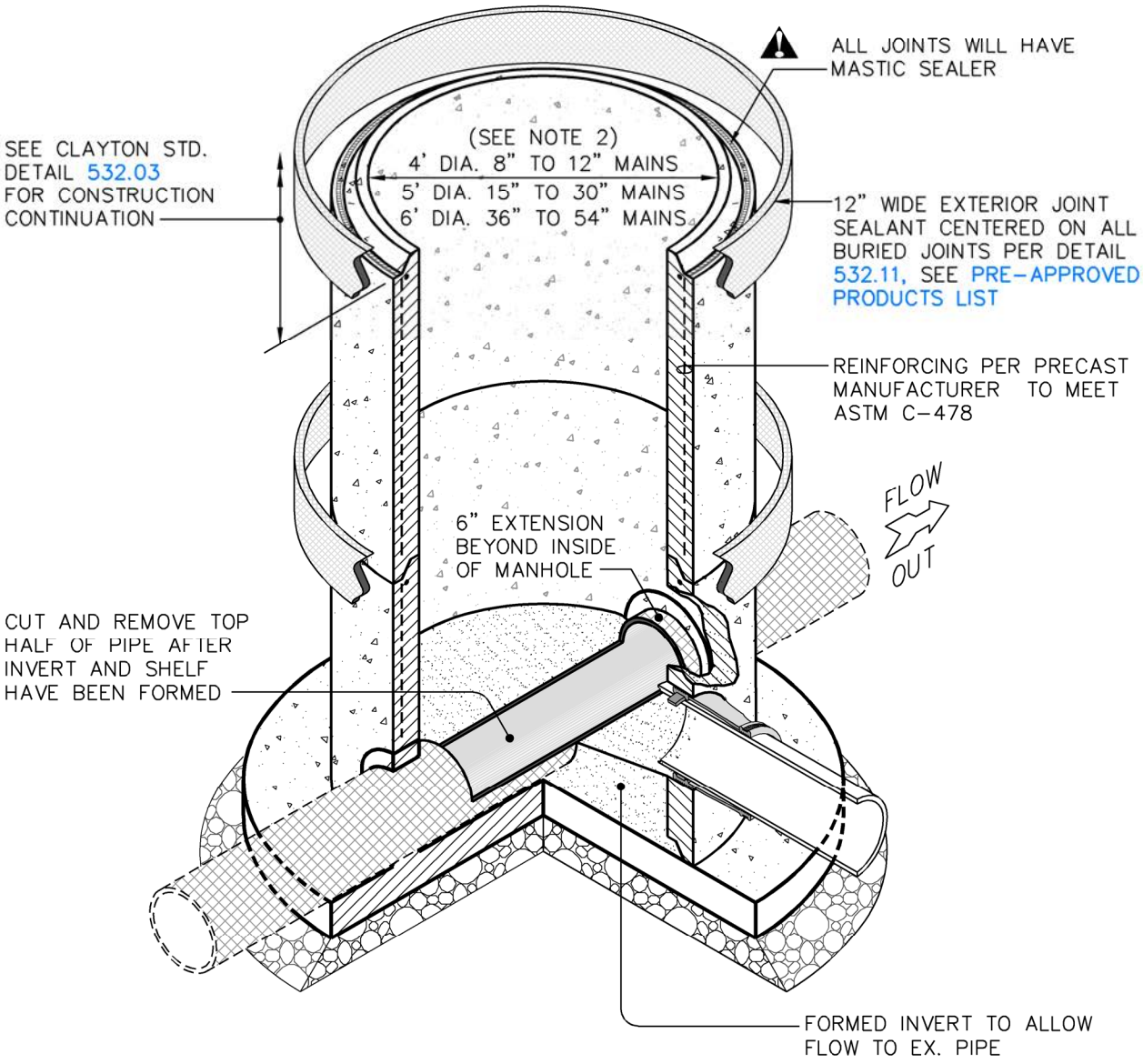
FOUNDATION SECTION VIEW

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

DOGHOUSE MANHOLE INSTALLATION OVER EXISTING SEWER MAIN

SCALE:	DETAIL #
Not To Scale	2 532.05
REVISION DATE: Oct., 2022	SHEET #: 1 of 2



INVERT SECTION VIEW

NOTES:

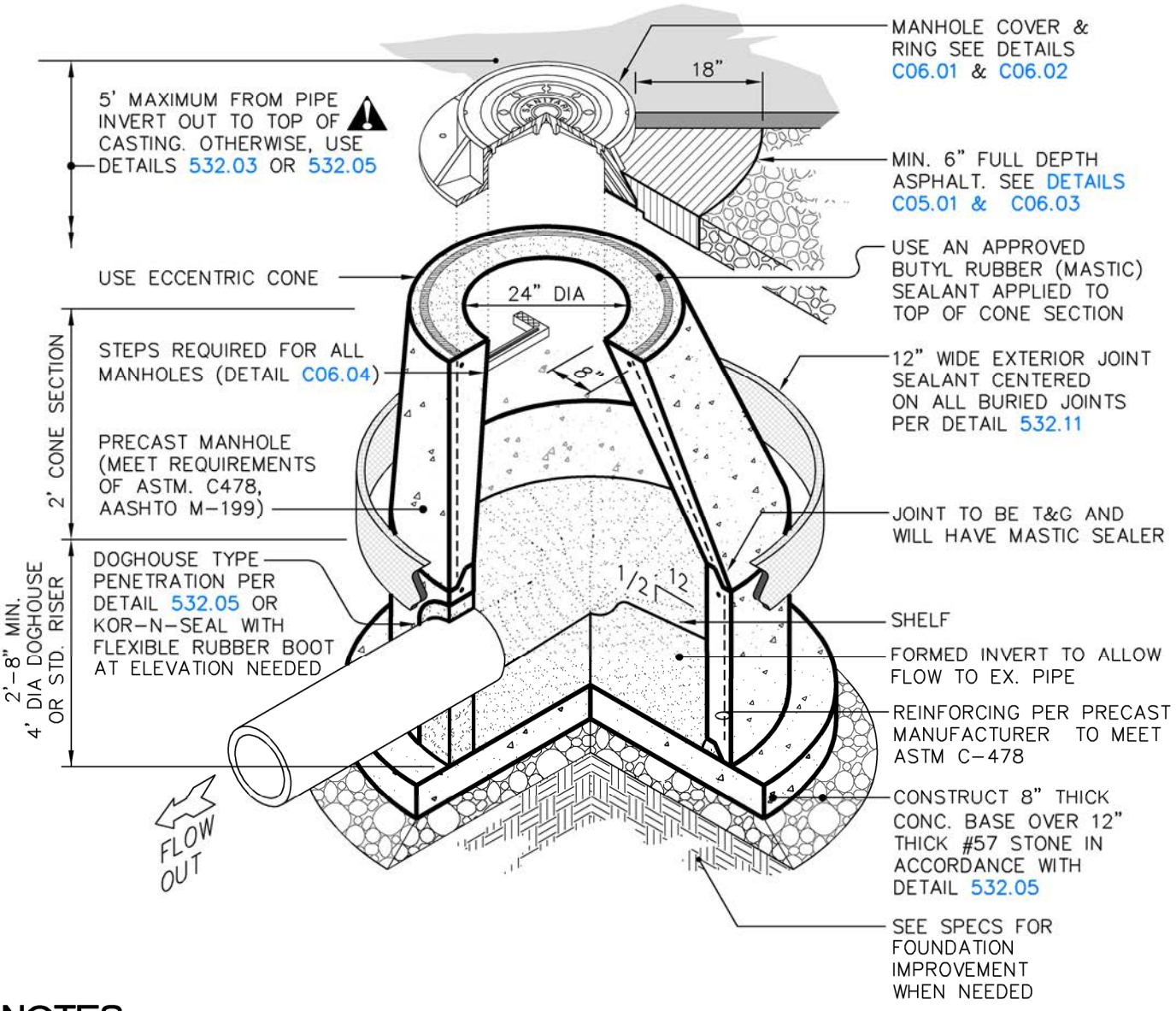
1. All service laterals into manhole to be core drilled and booted.
2. Maximum depth 4' dia. manhole = 12' (see specifications). Use 5' dia. manhole for depth greater than 12'.
3. Flow of existing main shall be maintained during construction.
4. This detail to be used when a 6" or larger lateral main necessitates construction of a new manhole.
5. Do not place grout at manhole section joints.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

DOGHOUSE MANHOLE INSTALLATION OVER EXISTING SEWER MAIN

SCALE:	DETAIL #
Not To Scale	2 532.05
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



NOTES:

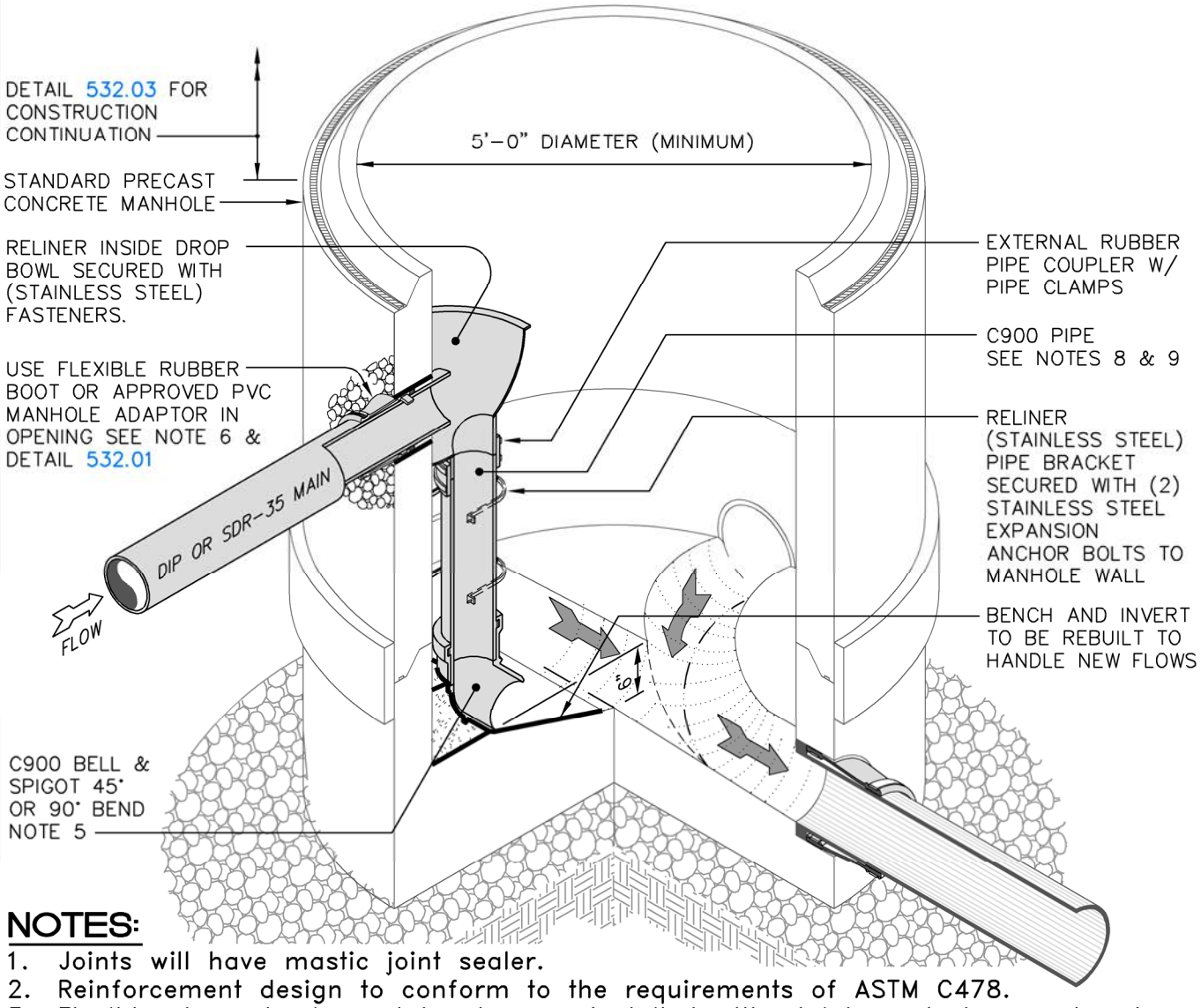
1. Concrete strength to be 3,000 PSI minimum.
2. Pipes will be grouted inside and out for Doghouse riser application.
3. Flexible sleeve boots cast in place or installed with stainless steel expander rings for Standard riser application. Boots to meet ASTM C-923 standards.
4. Service laterals into existing manholes to be core drilled and booted.
5. For watertight applications, place butyl rubber between frame and cone with water tight ring & cover.
6. For pipe connections 12" and larger, 2 sets of bands shall be required.
7. Lubricate the following: Pipe exterior, boot interior, boot exterior, S.S. bands (Top & bottom)
8. Place manhole opening over the effluent line.
9. Do not place grout at manhole section joints.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL SHALLOW PRECAST MANHOLE DETAIL

SCALE:	DETAIL #
Not To Scale	2 532.07
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

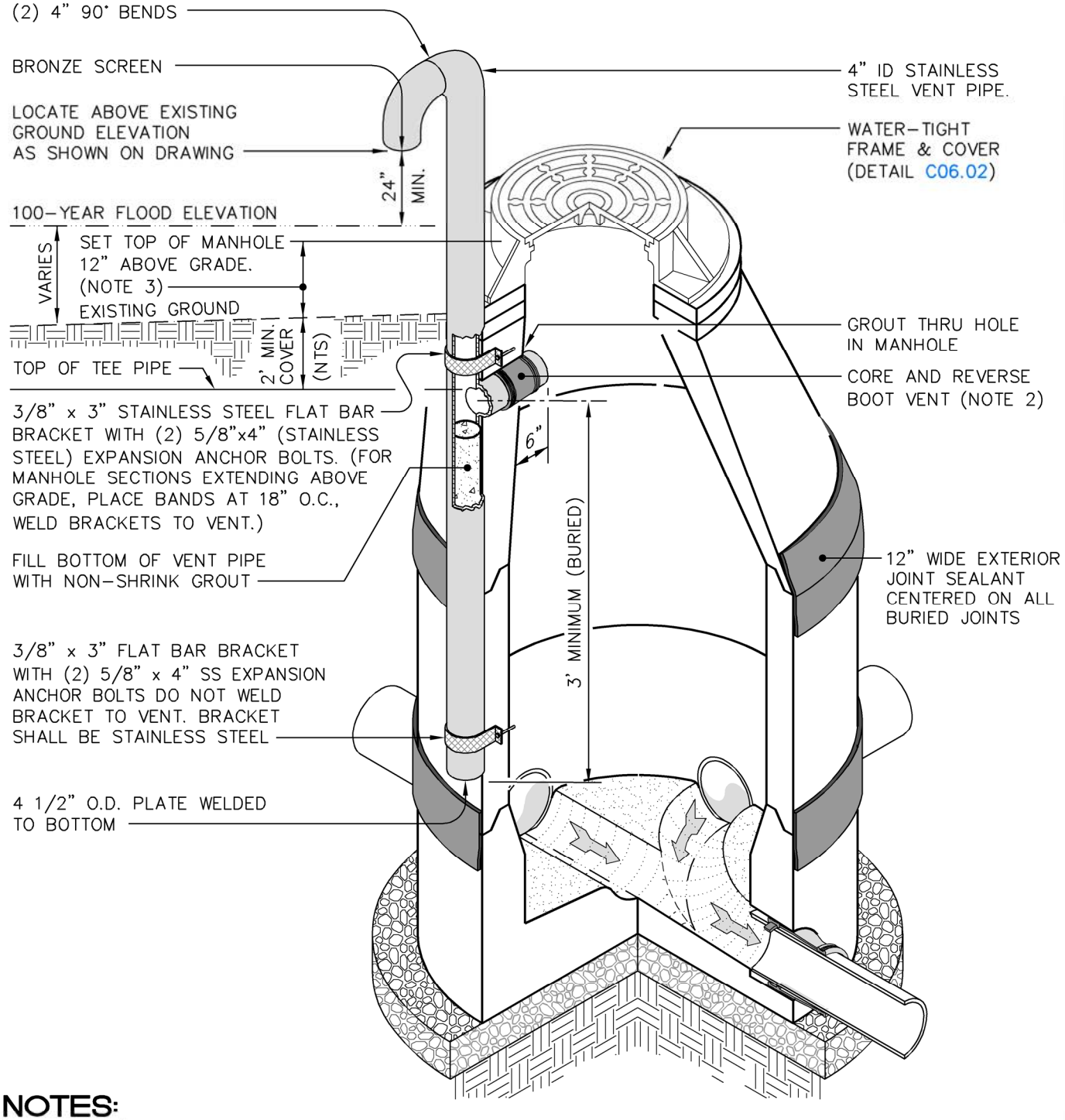
1. Joints will have mastic joint sealer.
2. Reinforcement design to conform to the requirements of ASTM C478.
3. Flexible sleeve boots cast in place or installed with stainless steel expander rings as manufactured by KOR-N-SEAL or PSX shall be used for pipe connections. Boots shall be secured to pipe using two (2) stainless steel bands. Precast inverts will not be accepted. Place compacted No. 57 stone around all boots.
4. The diameter of the vertical stack shall be equal to inlet pipe size but not less than 6". Drop stack to be C900 PVC pipe. The vertical stack shall be strapped to the manhole with a minimum of 1 S.S. strap on all drops. Drops greater greater than 5 feet at 18" intervals.
5. The elbow at the bottom of the stack to be placed in the direction of flow in the manhole with a channel constructed to conform to the manhole bench. Provide support for elbow.
6. Core drill hole for existing manholes, Precast or core drill hole for proposed manholes.
7. This detail shall not be used for force mains.
8. If more than one inside drop provide minimum 6' dia. manhole.
9. Maximum drop height of 30".

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

INTERIOR DROP INTO MANHOLE (FOR DROPS UP TO 12" DIA.)

SCALE:	DETAIL #
Not To Scale	2 532.09
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

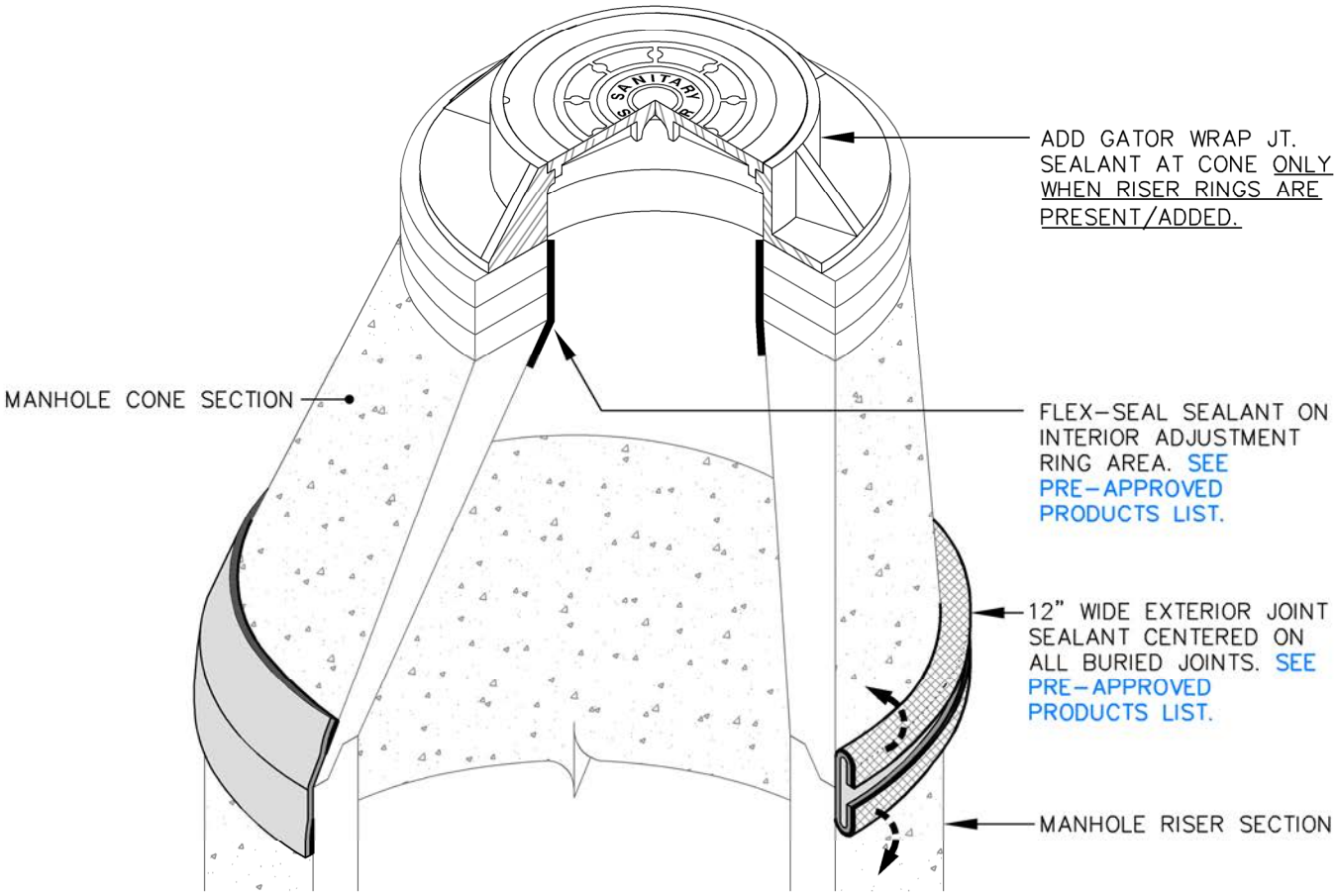
1. Locate vent pipe as shown or as directed by Engineering Director.
2. Connect 4" steel vent pipe to manhole with flexible boot.
3. If height above grade exceeds 24", use eccentric flat top.
4. See also Details 532.03 & 539.01 for manhole marker regulations.
5. Do not place grout at manhole section joints.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD MANHOLE VENTING DETAIL

SCALE:	DETAIL #
Not To Scale	2 532.10
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



MANHOLE APPLICATION

INSTALLATION NOTES:

1. See Pre-Approved Product List for acceptable material manufacturer and product.
2. Exterior Joint Sealant Installation Notes:
   a. Expose the area as the riser joint that is to be sealed. Clean the entire area around the joint with an abrasive tool. When finished cleaning, the entire area must be dry and free of any dirt.
   b. Remove the first foot of the paper backing from the mastic. Center and place the 12" wide Exterior Joint Sealant around the joint. Continue to remove the paper backing as you apply the Exterior Joint Sealant to the entire structure.
   c. Seal the overlapping area with a 6" overlap. Be sure not to stretch material at the overlap area.
   d. Cut excess material using a utility knife. Using a rubber mallet or hand held roller, firmly flatten the Exterior Joint Sealant 360 degrees around joint.

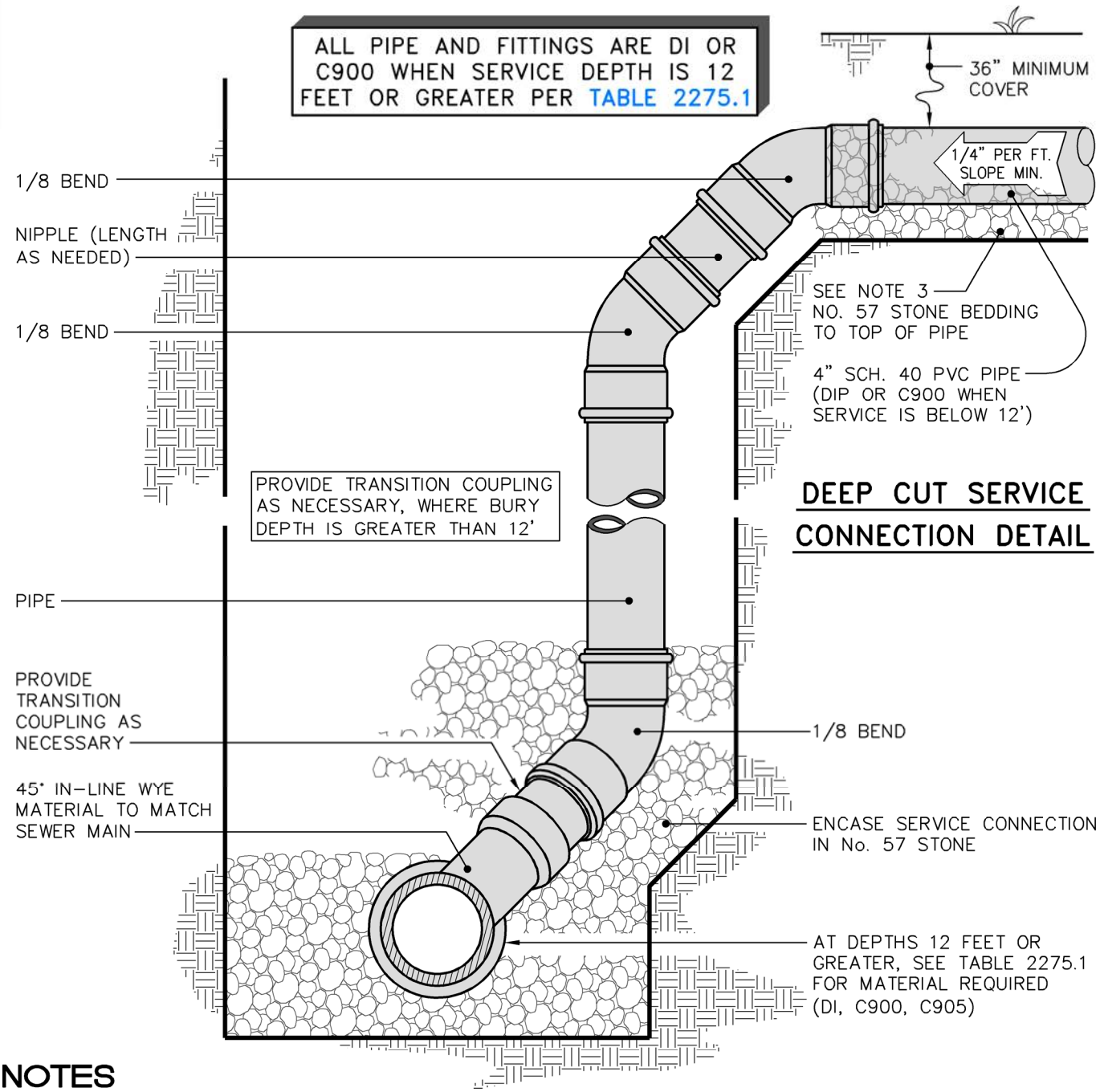
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

EXTERNAL JOINT SEALING DETAIL

SCALE:	DETAIL #
Not To Scale	2532.11
REVISION DATE: Oct., 2022	SHEET #: 1 of 1

ALL PIPE AND FITTINGS ARE DI OR C900 WHEN SERVICE DEPTH IS 12 FEET OR GREATER PER TABLE 2275.1



DEEP CUT SERVICE CONNECTION DETAIL

NOTES

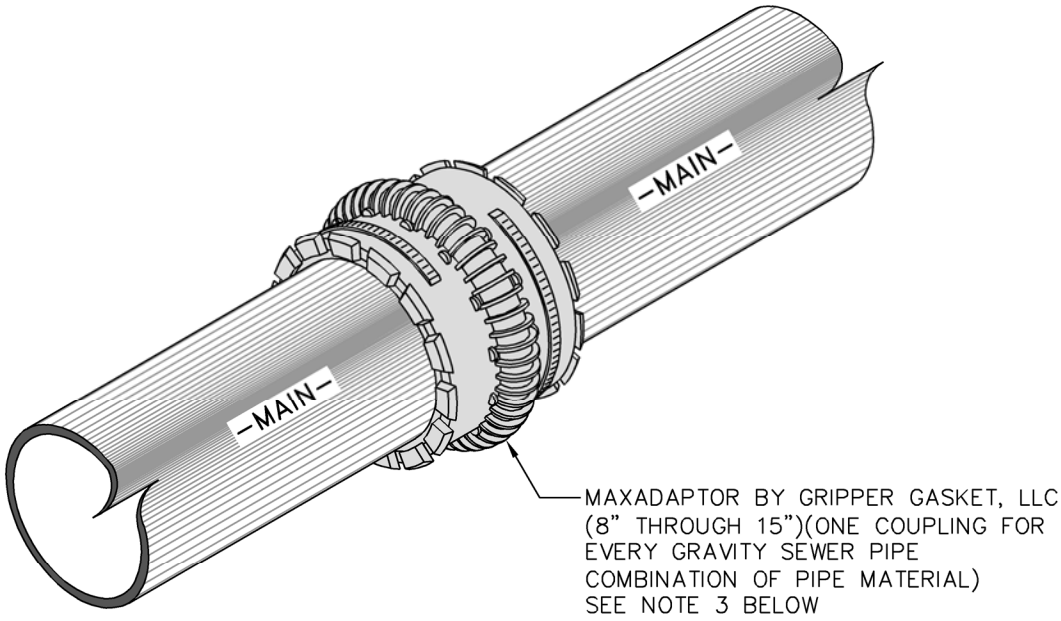
1. The full length of the service trench shall be compacted in 6" layers with mechanical tamp.
2. Solvent cement for pvc pipe and fittings to be ASTM D-2564
3. PVC wye, bend, lateral, & clean-out assembly must be bedded in #57 stone. Bedding and handling of service pipe must comply with Class B bedding (See bedding detail for gravity mains.)
4. 6 inch service connections to manhole only, using core and a rubber boot.
5. See sheet 3 of 3 for cutting in an in-line cone on an existing PVC or DIP main.
6. All bends below 12' feet need to be DIP or C900 per Table 2275.1

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL PVC SEWER LATERAL CLEANOUT WITH IN-LINE WYE

SCALE:	DETAIL #
Not To Scale	2533.01
REVISION DATE:	SHEET #:
Oct., 2022	2 of 4



PVC / DIP MAIN

COUPLING NOTES:

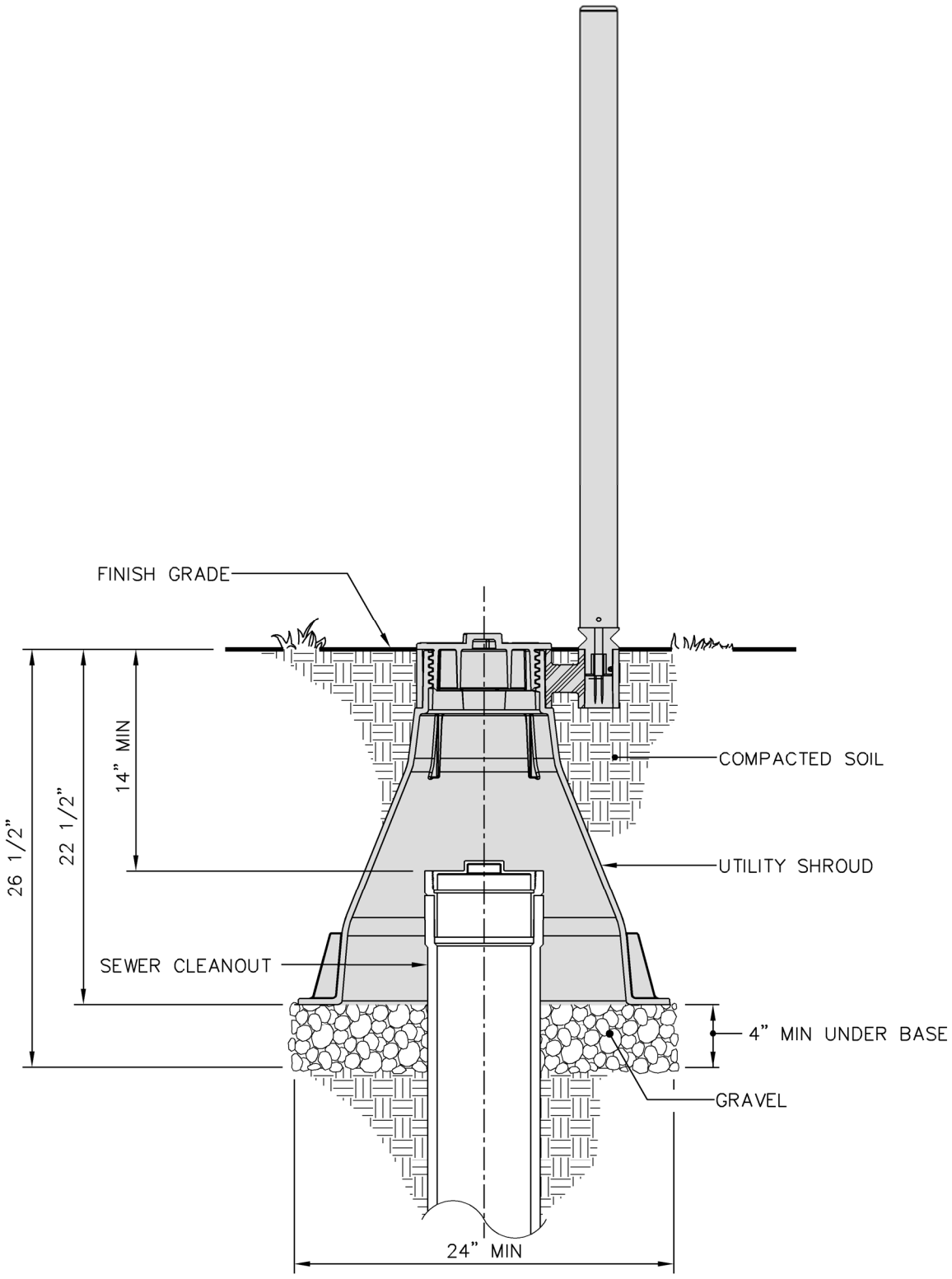
1. No Fernco couplings allowed for connections/transitions.
2. This gravity sewer transition coupling/connection for gravity sewer mains can be used either on a point repair, joining new pipe to existing, or as a coupling placed upstream of a cut–in inline wye as shown on Sheet 1 of this detail.
3. New construction is required to have one type of pipe material from manhole to manhole.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL PVC SEWER LATERAL CLEANOUT WITH IN-LINE WYE

SCALE:	DETAIL #
Not To Scale	2 533.01
REVISION DATE: Oct., 2022	SHEET #: 3 of 4

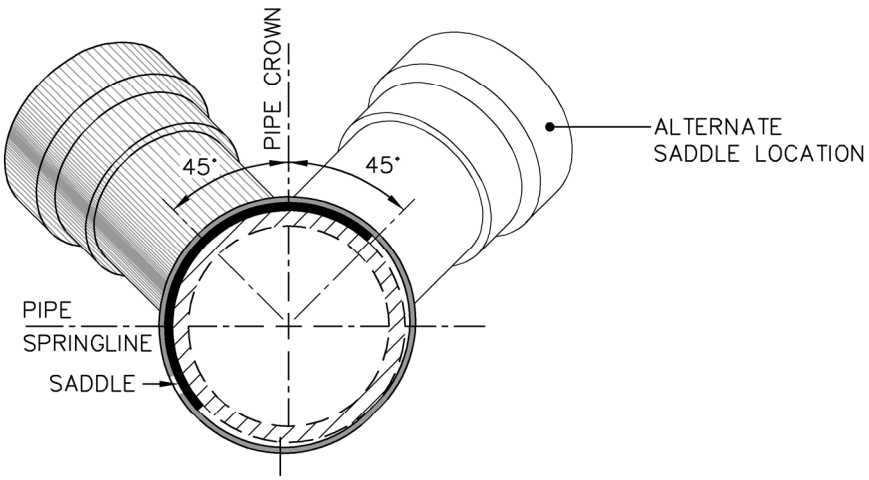


TOWN of CLAYTON

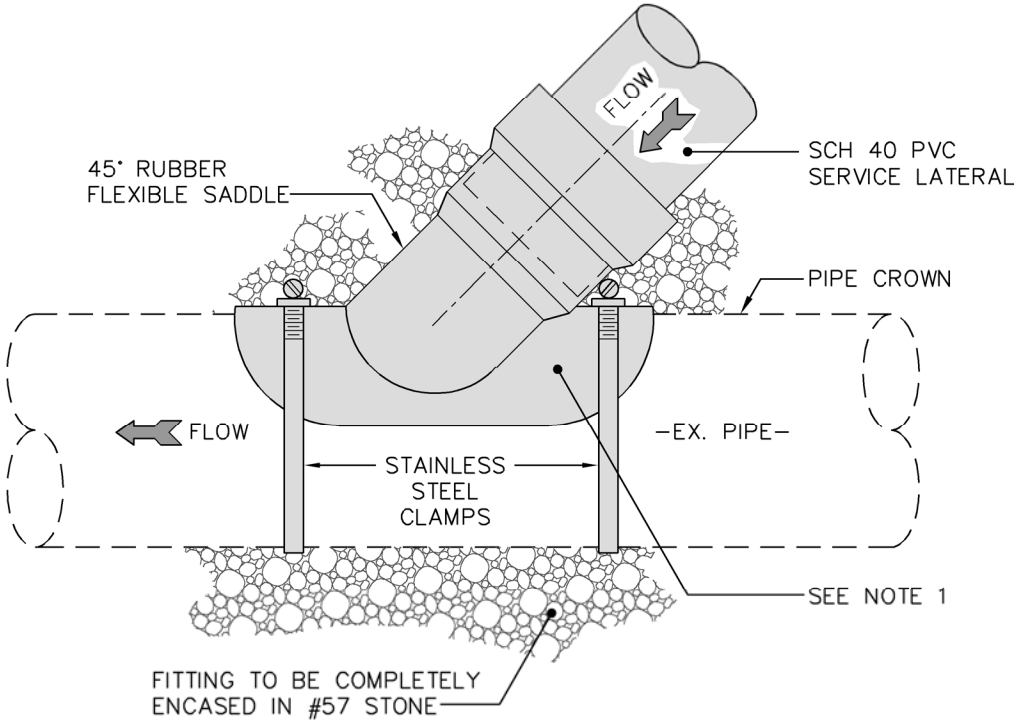
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

UTILITY SHROUD FOR SEWER CLEANOUT ASSEMBLY

SCALE:	DETAIL #
Not To Scale	2 533.01
REVISION DATE: Mar., 2023	SHEET #: 4 of 4



SADDLE INSTALLATION LIMITS



INVERT SECTION VIEW

NOTES:

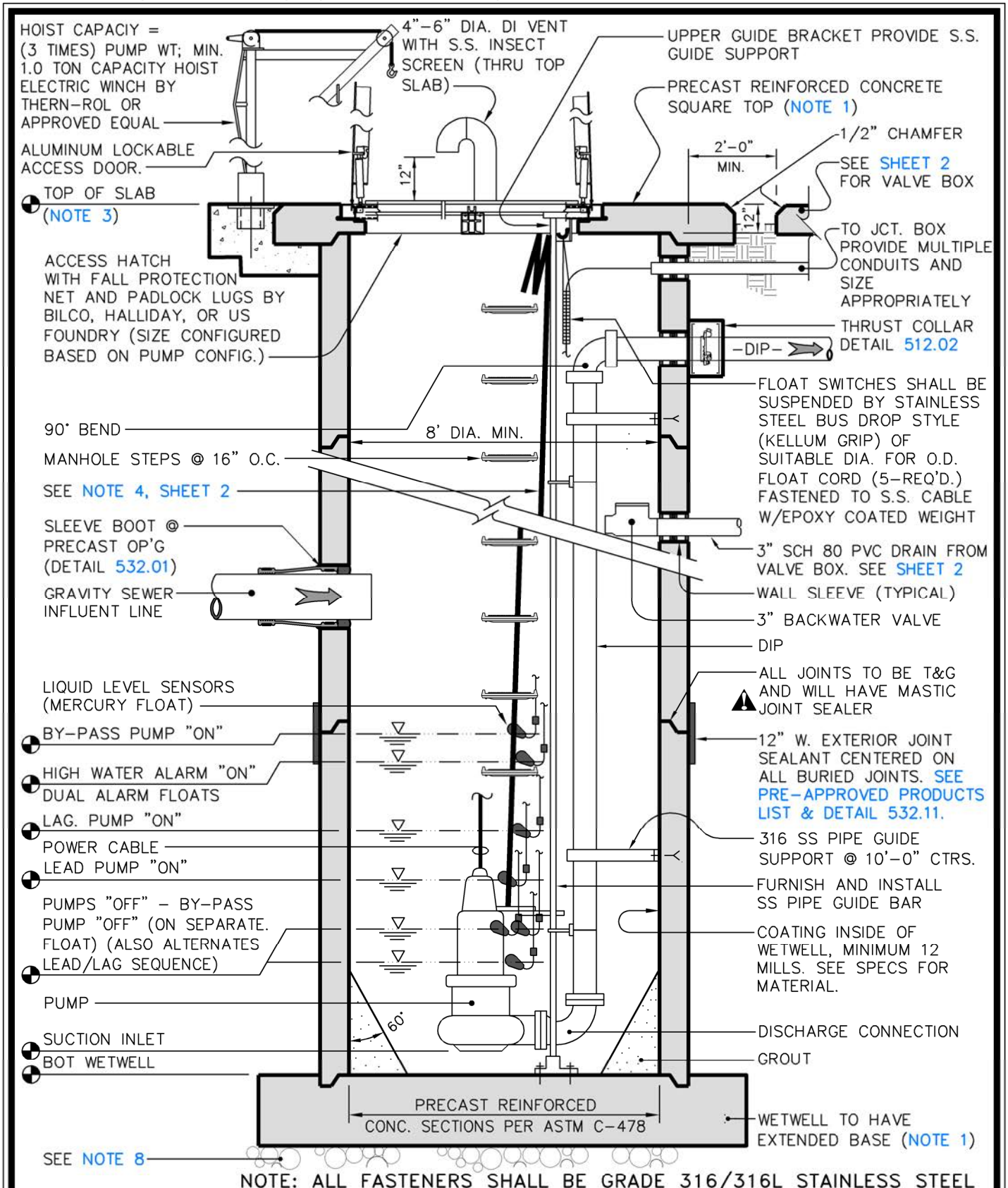
1. Existing mains only. – New construction must use In–Line Wye.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

LATERAL SADDLE INSTALLATION DETAIL FOR PVC PIPE

SCALE:	DETAIL #
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REVISION DATE:	SHEET #:
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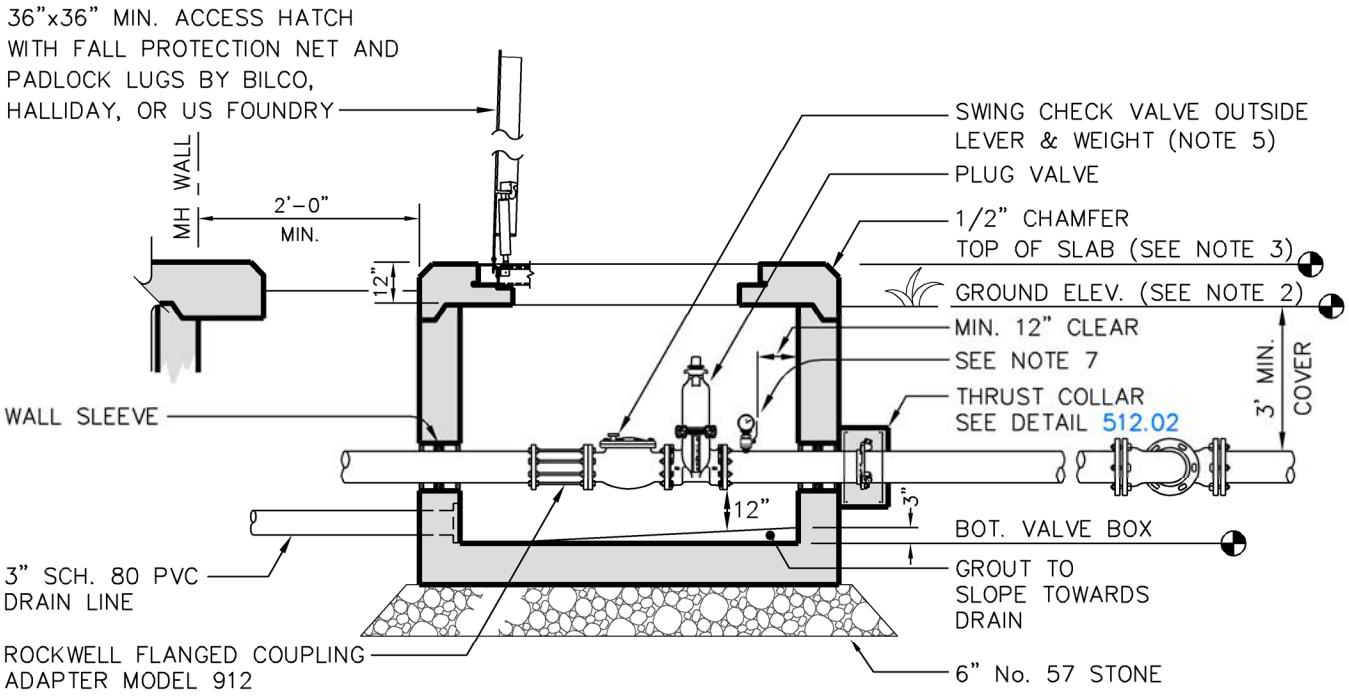


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WETWELL/VALVE VAULT DETAIL

SCALE:	DETAIL #
Not To Scale	2 534.02
REVISION DATE: Oct., 2022	SHEET #: 1 of 5



NOTES:

1. Wetwell shall be checked for floatation and shall be ballasted as required to prevent buoyancy. Top slab must have adequate thickness and be adequately reinforced designed by N.C. PE.
2. Ensure positive drainage away from wetwell and valve box.
3. Top of slab for both wet well and valve vault to be min. 100 yr. base flood elevation + 2 feet of free board. (Ref Town of Clayton Flood Plain Ordinance)
4. Stainless steel cable attached to pump bridle. Coil up extra length at hatch. Length to be sufficient to connect to hoist.
5. Cushioned check valves for high head applications as determined by the Engineering Director. Plug valves 6" and larger shall be gear activated.
6. Provide min. 12" of clearance around all flanges from walls, floor, and other flanges & 24" between flanges of parallel pipes.
7. Glycerin or silicone filled pressure gauge, sized appropriately, visible from top of vault, with 1/4 turn ball valve, direct tap.
8. Geotech report required for base and backfill requirements. Min 1' deep over excavate & backfill with No. 57 stone.
9. In wet well, use floats. Transducers not permitted.
10. Pump Station lot to be deeded separate w/road frontage. Easements are not acceptable.
11. Future gravity connections to pump station shall be made to a manhole upstream and outside station site.
12. Provide vehicle access to one side of wetwell for maintenance of wetwell & pumps.
13. Ensure access is provided to utility easements either thru or outside and adjacent to station site.
14. A manhole shall be placed upstream & inside of fenced station site.
15. A building to house control panel may be substituted for NEMA 4 enclosure and rainhood. Building to include thermostatically controlled ventilation (fan and louver) and light. Building to be approved by Town of Clayton Engineering Director.

TOWN of CLAYTON

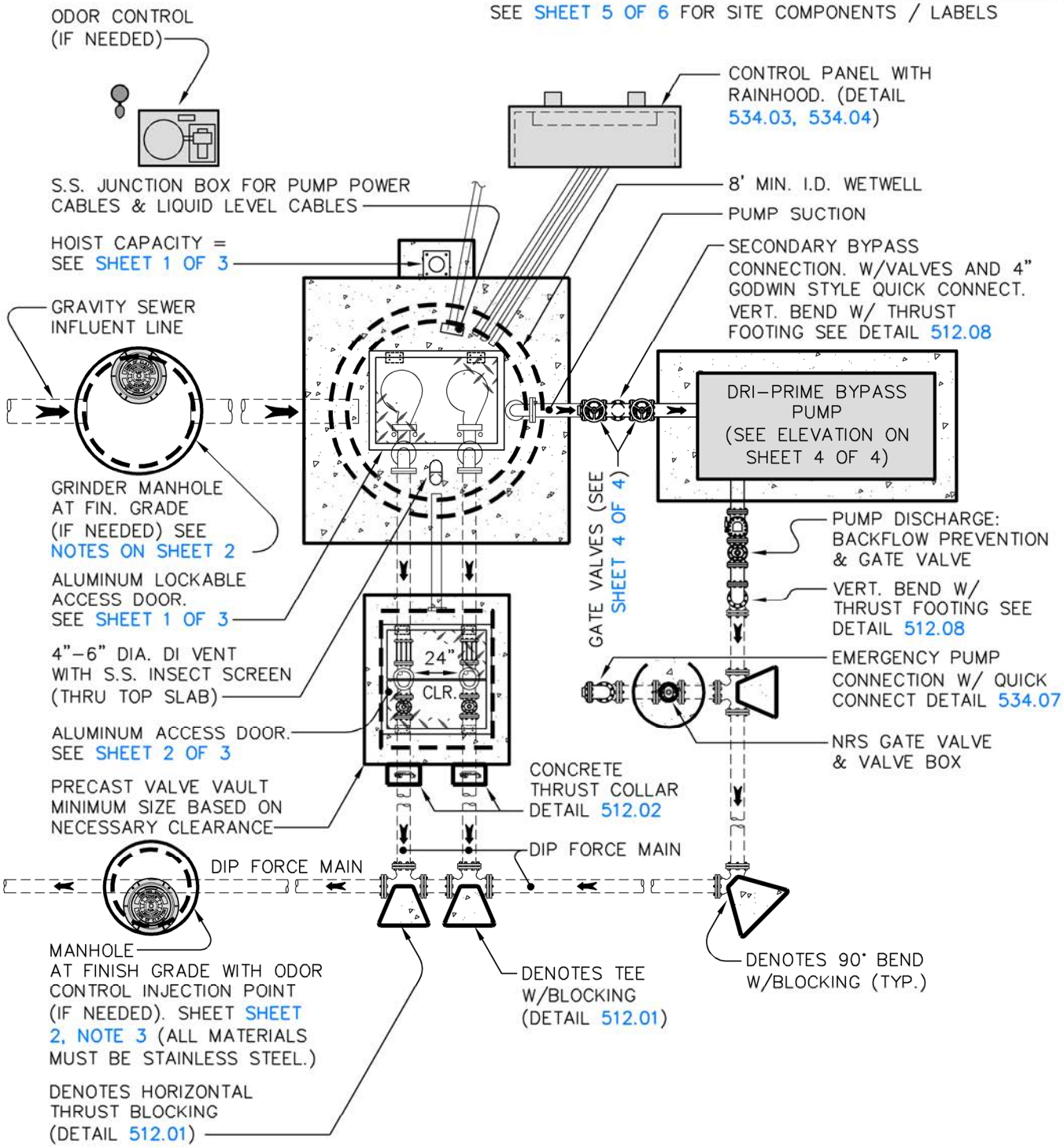
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WETWELL/VALVE VAULT DETAIL

SCALE:	DETAIL #
Not To Scale	2 534.02
REVISION DATE: Oct., 2022	SHEET #: 2 of 5

STANDARD LIFT STATION LAYOUT

SEE SHEET 5 OF 6 FOR SITE COMPONENTS / LABELS

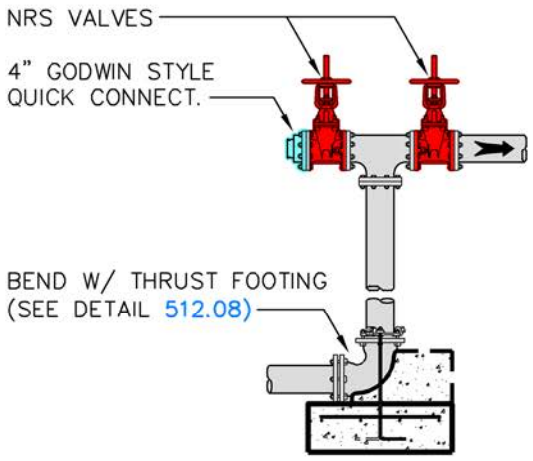


TOWN of CLAYTON

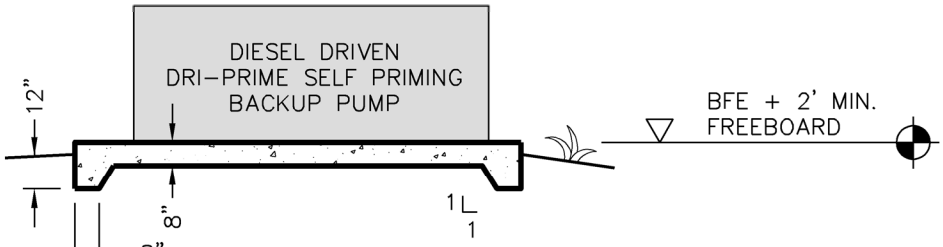
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WETWELL/VALVE VAULT DETAIL

SCALE:	DETAIL #
Not To Scale	2 534.02
REVISION DATE: Oct., 2022	SHEET #: 3 of 5



SECONDARY BYPASS SCHEMATIC



ELEVATION

NOTES:

1. Control panel to be installed facing wetwell.

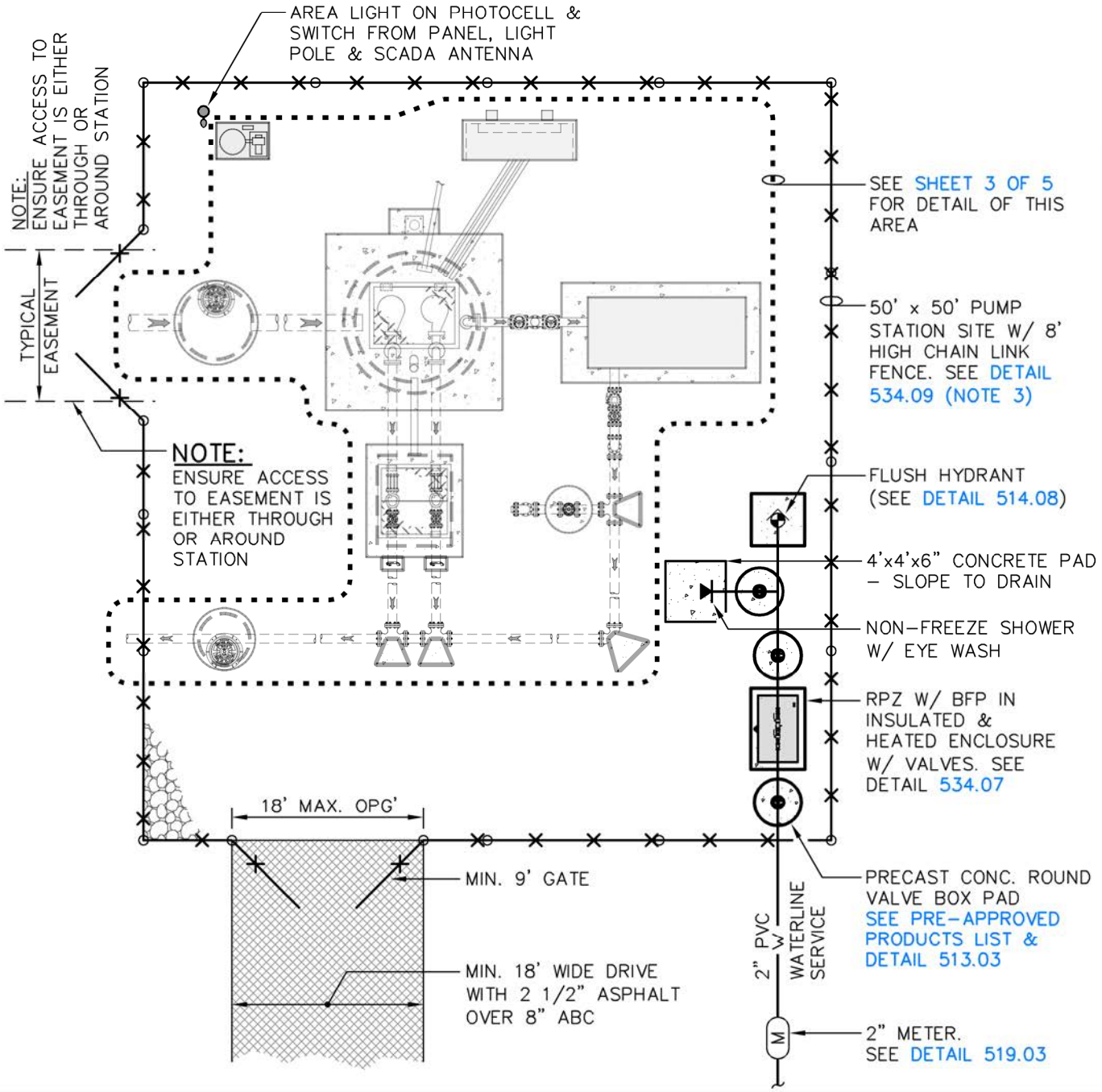
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WETWELL/VALVE VAULT DETAIL

SCALE:	DETAIL #
Not To Scale	534.02
REVISION DATE:	SHEET #:
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STANDARD LIFT STATION SITE

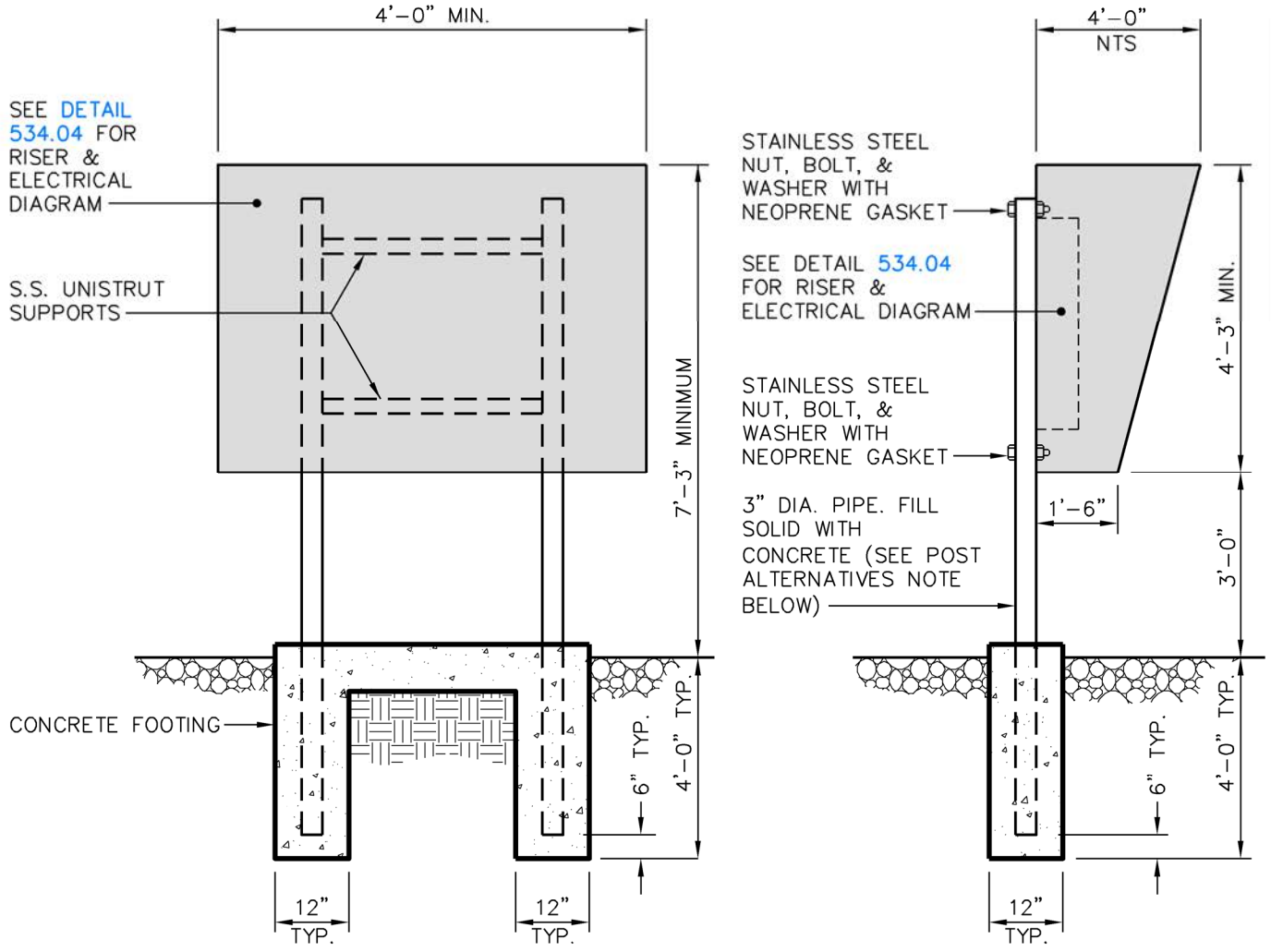


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL WETWELL/VALVE VAULT DETAIL

SCALE:	DETAIL #
Not To Scale	2 534.02
REVISION DATE: Oct., 2022	SHEET #: 5 of 5



POST ALTERNATES:

1. 3" SCH 40 Stainless Steel 304/304L Pipe.
2. 3" SCH 40 Aluminum Round Pipe 6061–T6.

NOTES:

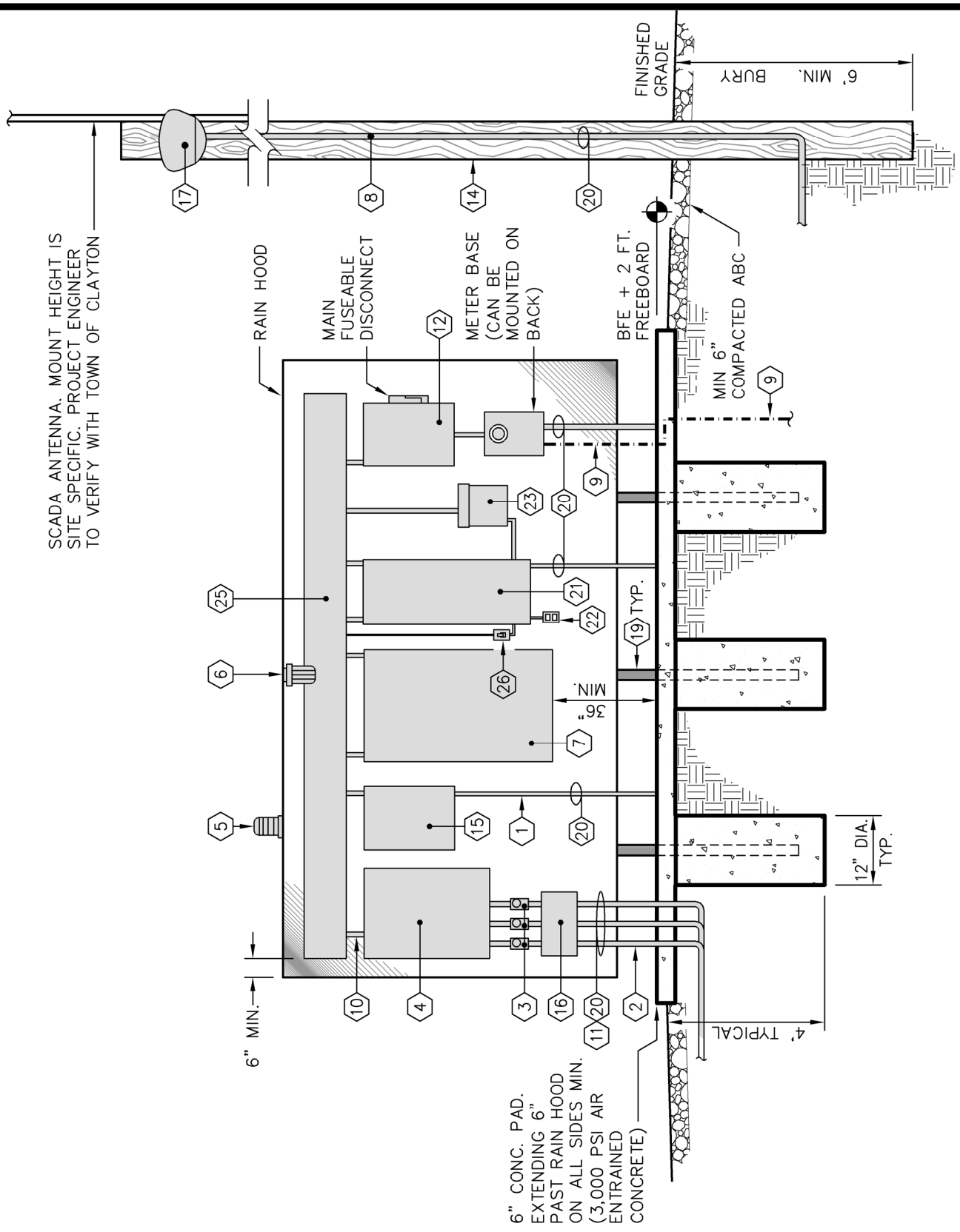
1. Contractor shall verify control panel size before construction of rainshield and modify as required.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RAINHOOD DETAIL

SCALE:	DETAIL #
Not To Scale	2 534.03
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RISER and ELECTRICAL DIAGRAM

SCALE:	DETAIL #
Not To Scale	2 534.04
REVISION DATE: Oct., 2022	SHEET #: 1 of 2

⟨#⟩	PART
1	CONDUIT FOR SCADA
2	PVC (TO WETWELL) FOR LIQUID LEVEL CONDUITS
3	(3) "SEAL–OFFS" USING NON–HARDENING SEALING MATERIAL
4	PUMP CONTROL PANEL WITH RAIN HOOD (DETAIL 534.03 & 534.04)
5	RED ALARM FLASHING LIGHT W/ HORN. MIN. 90dB
6	UNDER HOOD PANEL LED LIGHT
7	AUTOMATIC TRANSFER SWITCH FOR GENERATOR PUMP (NOT REQUIRED WHEN BACKUP PUMP IS USED)
8	POWER FROM CONTROL PANEL TO AREA LIGHT
9	#8 GROUND TO DRIVEN GROUND ROD (OBTAIN 25 OHM RESISTANCE OR LESS)
10	GROUND (VERIFY WITH NEC)
11	PVC CONDUITS FOR PUMP LEADS (PROVIDE SEPERATE CONDUIT FOR EACH PUMP)
12	3 FUSE SERVICE RATED DISCONNECT NEMA 3R FUSE
13	COPPER (THWN) IN CONDUIT TO DISCONNECT
14	25' CLASS 5 TREATED POLE FOR AREA LIGHT (BY CONTRACTOR)
15	SCADA
16	SS JUNCTION BOX FOR PUMP POWER CABLES & LIQUID LEVEL CABLES (JUNCTION BOX TO BE NO MORE THAN 5 FEET FROM HATCH).
17	AREA LIGHT WITH SWITCH CONTROL AND PHOTO CELL
18	CONCRETE FOOTING FOR SUPPORT POSTS
19	3" SCH 40 SS PIPE (TYPICAL). SEE DETAIL 534.03 FOR OTHER MATERIAL OPTIONS. FILL SOLID WITH CONCRETE.
20	ELECTRICAL CONDUIT BY ELECTRICAL CONTRACTOR
21	SERVICE PANEL WITH MAIN DISCONNECT
22	110V GFCI PROTECTED WEATHERPROOF DUPLEX RECEPTACLE
23	XFMER, SEE NOTE 2 BELOW
24	OMITTED
25	WIRE RACEWAY – OPTIONAL
26	WEATHERPROOF SWITCH FOR LIGHT

NOTES:

1. Underground service by contractor from meter base & transformer. (Transformer and meter base provided by power provider)
2. Service to be 3 phase, 4 wire, 277/480V. (Phase & voltage availability to be verified by project engineer based on site specifics.)
3. Use copper wire conductors with 600 volt "THWN–THHN" insulation.
4. Electrical service to meet N.E.C. & N.C. Electrical Code.
5. Panel layout is schematic only. Adjust as needed to accommodate equipment and Town of Clayton specifications. Maintain 4" min. clearance between panels and side shield.
6. All enclosures shal be NEMA 4X rated and lockable.
7. Provide neoprene spacers between enclosures and backplate of enclosures.
8. Conduit shall be rigid aluminum with Meyers Hubs at all panel connections.
9. All equipment shall be mounted min. 36" above finished grade.
10. See detail 534.02 for min. requirements of enclosure.

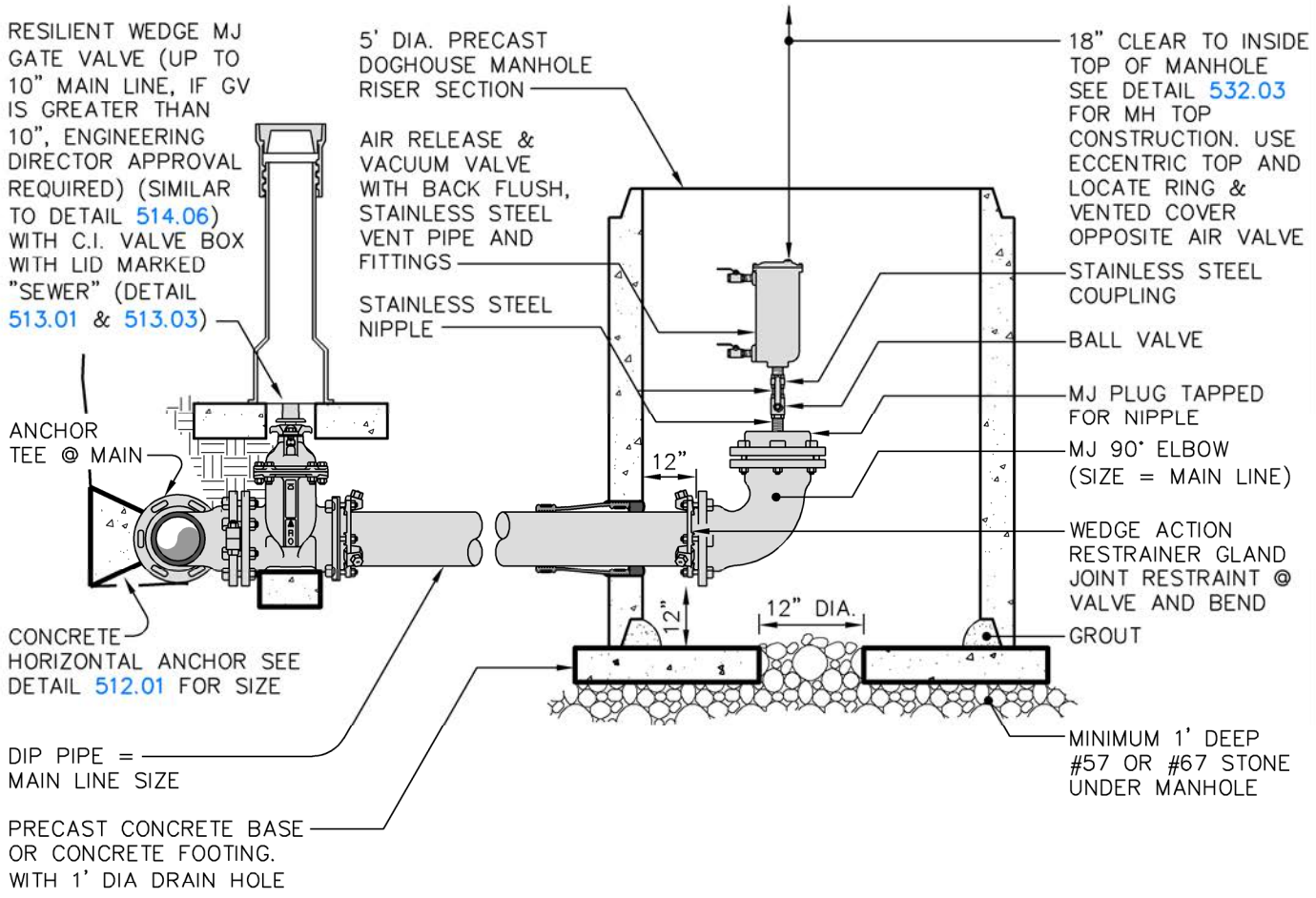
TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

RISER and ELECTRICAL DIAGRAM

SCALE:	DETAIL #
Not To Scale	2 534.04
REVISION DATE: Oct., 2022	SHEET #: 2 of 2

PART	MANUFACTURER MODEL / Cat. No.
COMBO A.R. & VACUUM VALVE	SEE PRE-APPROVED PRODUCT LIST FOR MANUFACTURER AND MODEL NUMBER



NOTES:

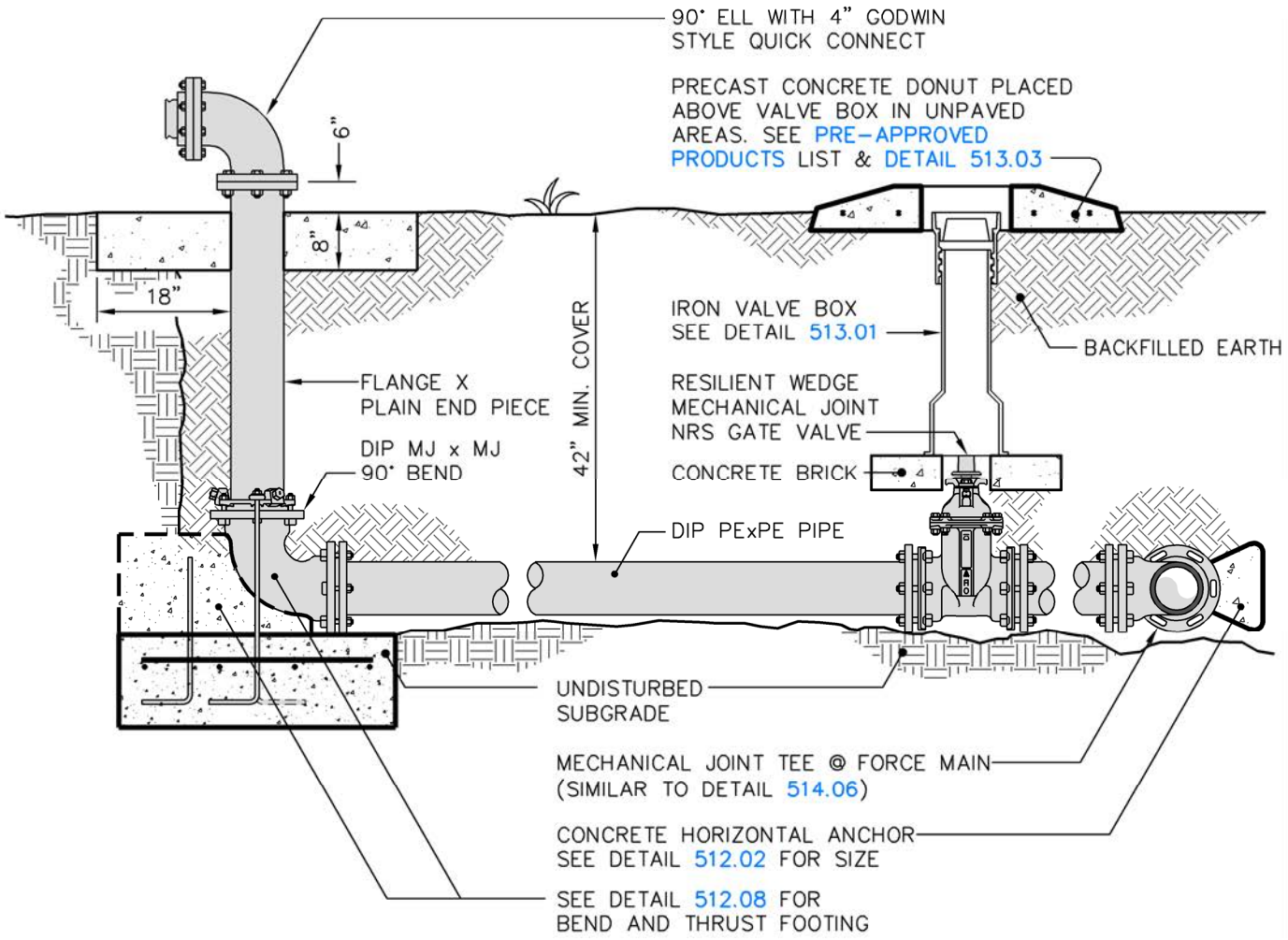
1. Provide a minimum of 3'–6" cover over sewer line.
2. All pipe fittings to be stainless steel.
3. Ensure 12" minimum clearance between manhole wall and floor to MJ elbow.
4. Ensure 18" minimum clearance between manhole top to air valve.
5. Manhole penetration to be precast or cored and booted.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

FORCE MAIN AIR / PRESSURE RELEASE VALVE IN MANHOLE

SCALE:	DETAIL #
Not To Scale	2 534.06
REVISION DATE: JAN., 2024	SHEET #: 1 of 1

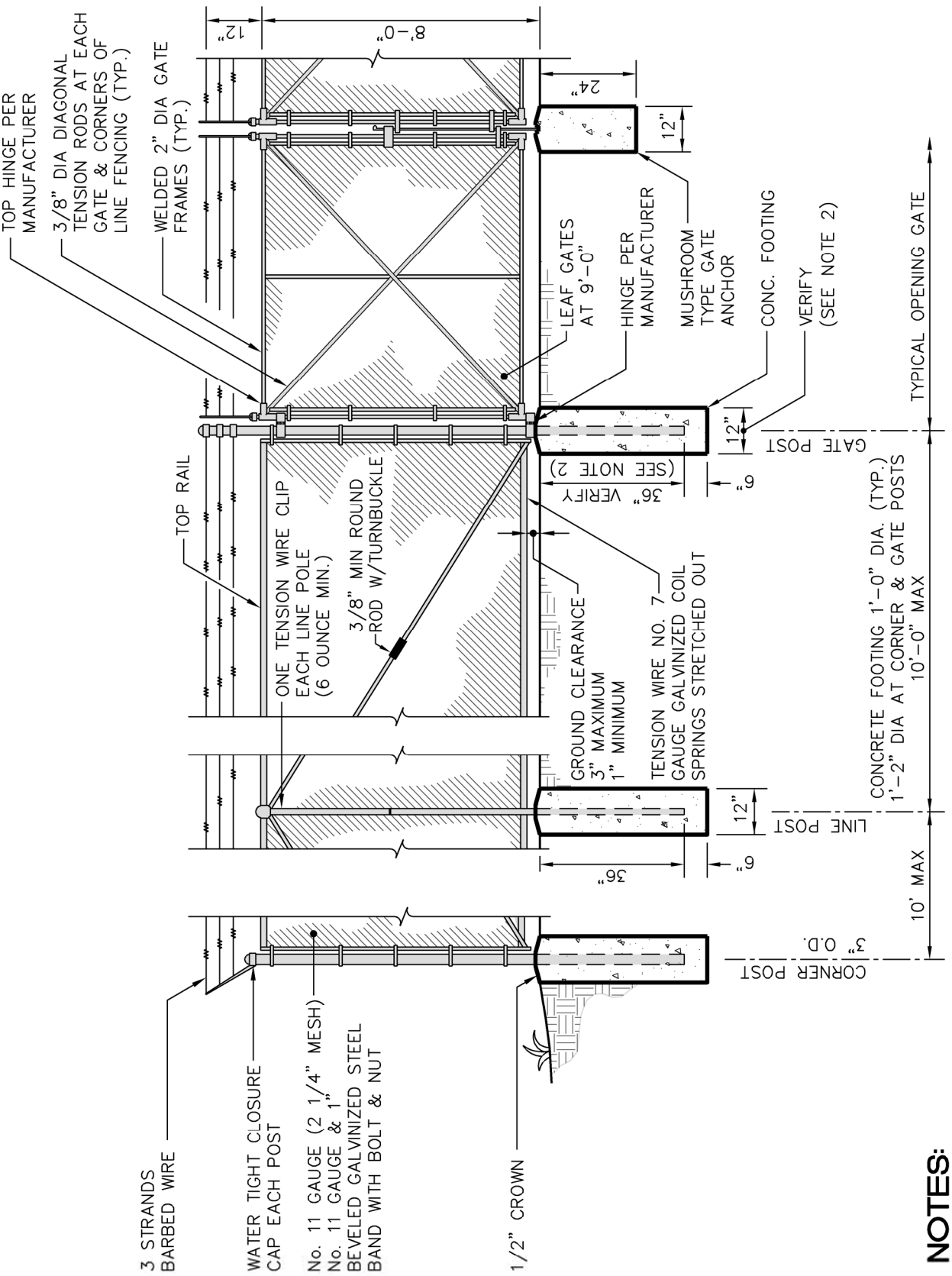


TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL EMERGENCY PUMP CONNECTION

SCALE:	DETAIL #
Not To Scale	2 534.07
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



NOTES:

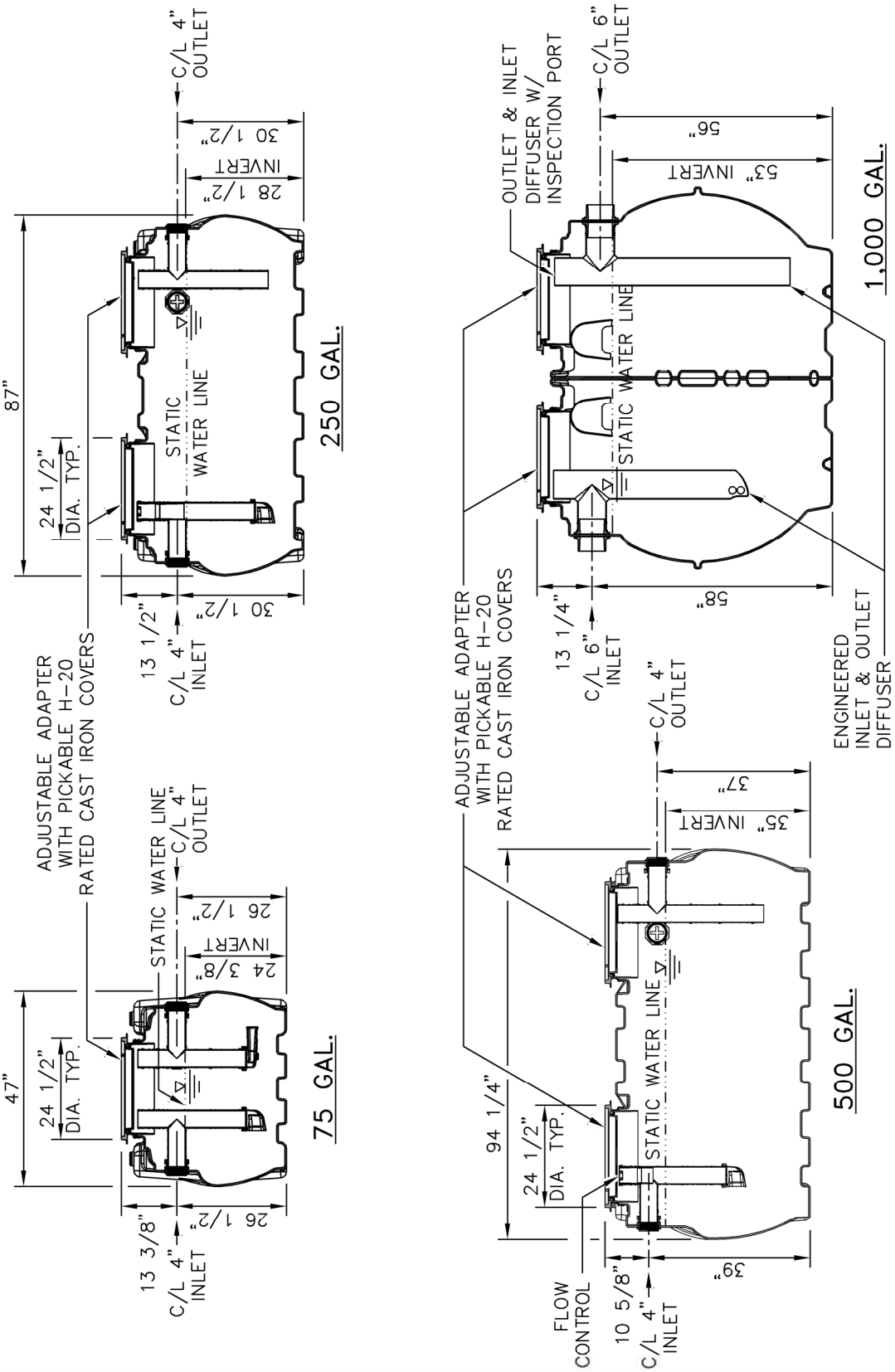
1. Chain link fabric to have slats & must be opaque. Verify fencing fabric requirements with U.D.O.
2. Project Engineer to verify adequacy of gate post footings for a 9' long gate (allow for wind load due to fence opaqueness and gate load).

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL CHAIN-LINK FENCE DETAIL - 8 FT. HEIGHT

SCALE:	DETAIL #
Not To Scale	2 534.09
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

GREASE INTERCEPTOR TANKS

SCALE:	DETAIL #
Not To Scale	2535.01
REVISION DATE: Oct., 2022	SHEET #: 1 of 2

NOTES:

1. Drawings are typical for hydromechanical interceptors approved for outdoor installation.
2. Materials of construction must be compatible with a pH of 3 (Concrete or acid resistant enamel coatings not allowed)
3. Inlet and outlet connections to be 6".
4. Covers shall be vehicle traffic rated (H20 or HS20) and shall be water tight.
5. Cleanouts shall be provided upstream and downstream of the grease interceptor within 3'.
6. Anti–flotation support shall be provided where high water table exists.
7. Safety star or equivalent access restrictor shall be provided under cover(s) to prevent accidental entry into tanks.
8. Installation shall comply with the manufacturer's instructions.
9. Sizing shall be in accordance with manufacturer's instructions and shall include both flow rate and grease capacity calculations for 90 day pump out frequency.

GREASE INTERCEPTOR TANK INSTALLATION GUIDE:

1. The tank is to be bedded in a minimum of 6 inches of pea gravel aggregate.
2. The tank belly is to be backfilled up to the haunches with screened material (sand, pea gravel, stone screenings, or other similarly graded material). Native materials is acceptable if it exhibits the same characteristics as select fill. Corrugations must be packed solidly with backfill. Compact in 6–inch lifts.
3. To avoid tank displacement and ensure uniform compaction, backfill around tank uniformly in single lifts using either screened select fill as noted above or native soil free of debris, sharp stones, and stones greater than 2 inches in diameter. All backfill must flow freely into corrugations between tank ribs.
4. Backfill tank to top of roof, between risers, and then around tank end walls.
5. Compact all backfill in 6–inch lifts.
6. In areas of high groundwater, the tank must be filled immediately following backfill.
7. Tanks are not typically designed or rated for heavy vehicular traffic. Unless otherwise permitted by tank manufacturer (after following manufacturer's instructions for tank backfill and compaction of tank), do not locate tank in an area where heavy vehicles may cross above tank.
8. Verify inlet/outlet elevations required with utility plan. If risers are required to adjust to finished grade, verify the maximum riser height permitted with tank manufacturer to ensure that fill above tank is not greater than manufacturer will allow for the prescribed tank.
9. Installer may place water in the tank to stabilize during backfilling.

GENERAL:

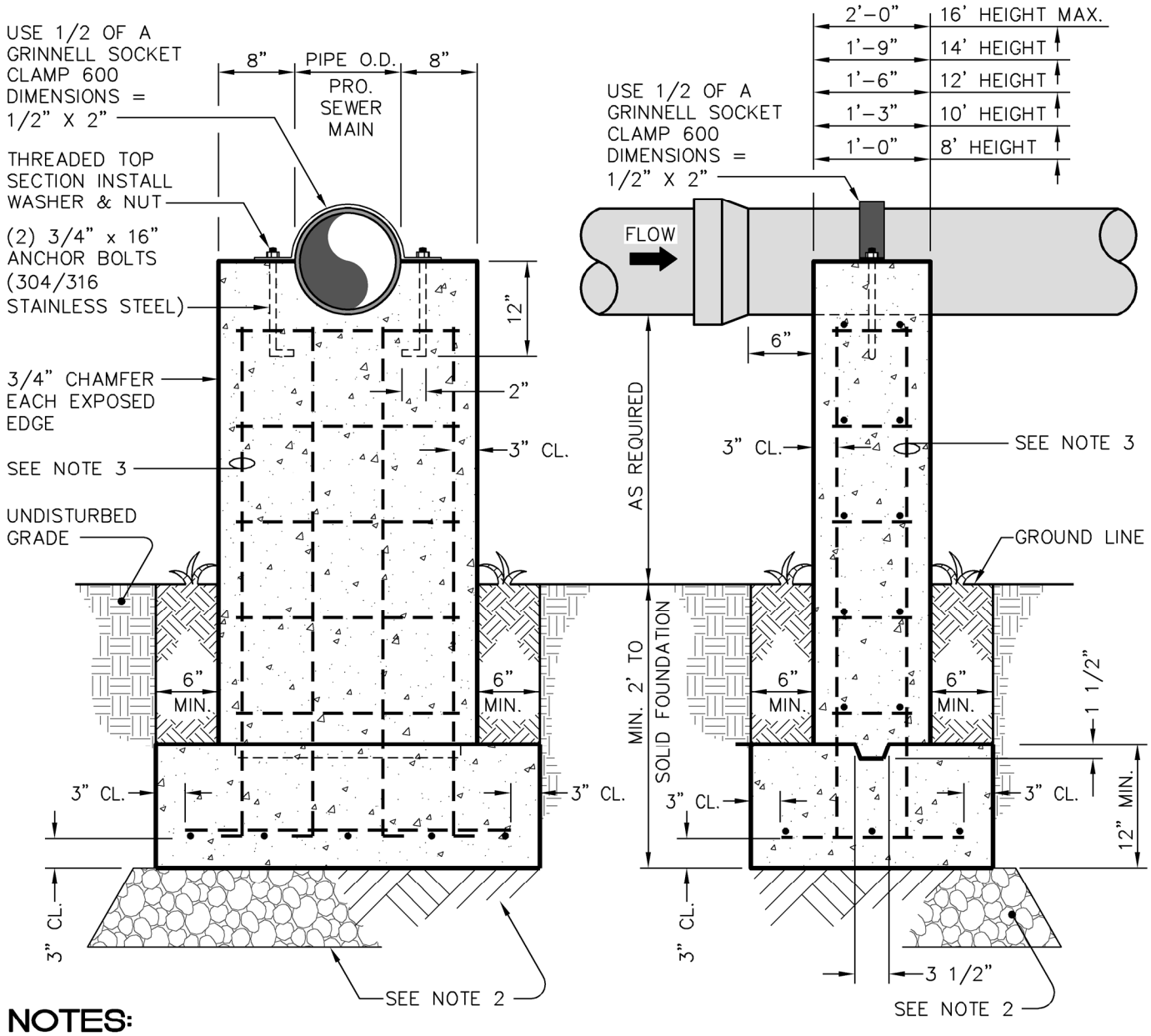
1. Obtain required tank installation permit as required.
2. Inspect tank for any damage. Unless otherwise approved by manufacturer, reject if damaged.
3. Perform required water tightness, plumbing, and/or tank inspection as required by local plumbing inspector.
4. To avoid weakening tank, internal water temperatures shall not exceed 140 degrees Fahrenheit.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

GREASE INTERCEPTOR TANKS

SCALE:	DETAIL #
Not To Scale	2535.01
REVISION DATE: Oct., 2022	SHEET #: 2 of 2



NOTES:

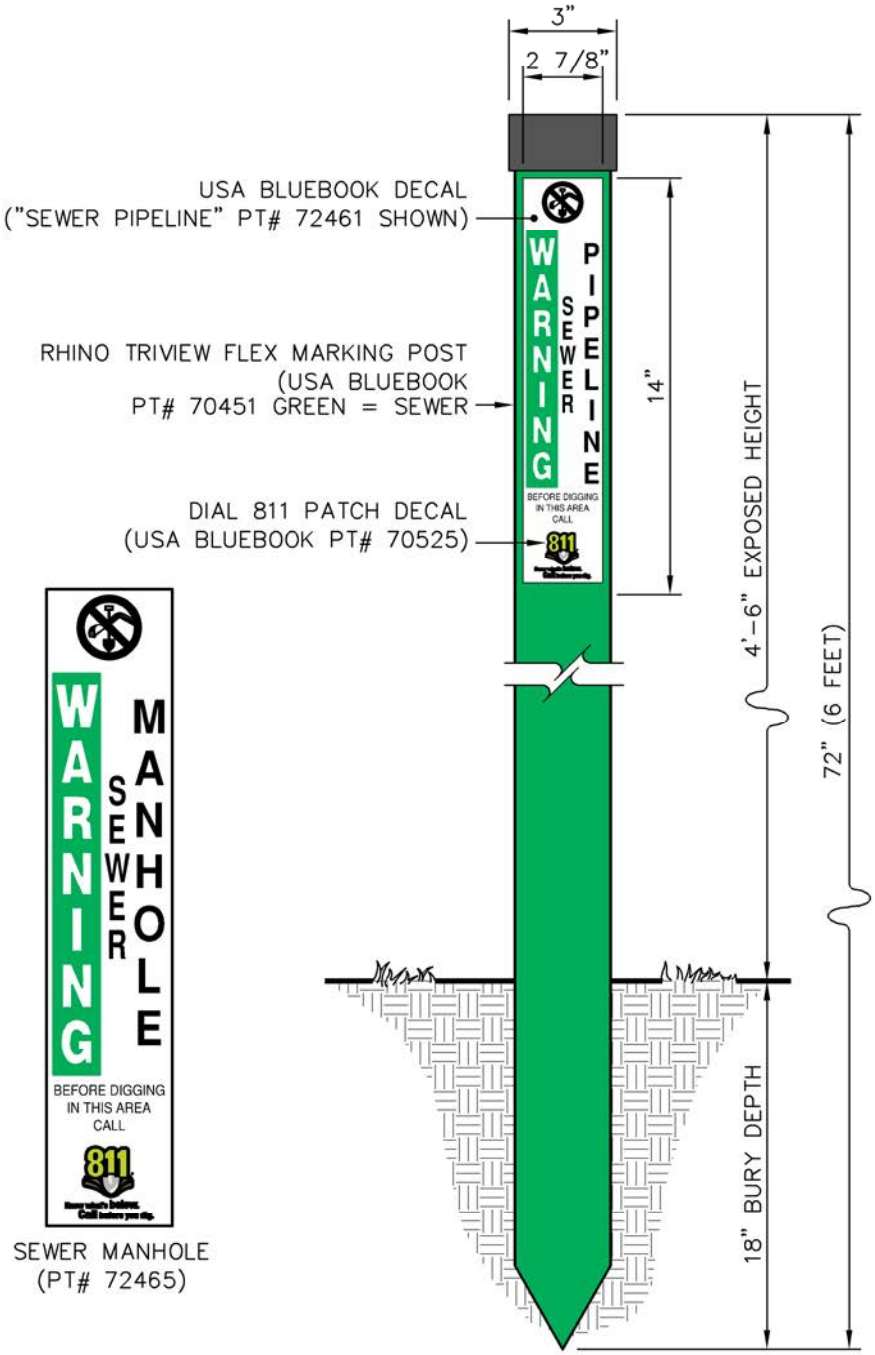
1. All hardware to be stainless steel.
2. A North Carolina Professional Engineer shall provide the necessary structural design for the pier sufficient to resist the forces acting on the pier/pipe system. Where shallow rock is found to exist, pin footing to rock by drilling & epoxying dowels into the rock. Provide computations to Clayton w/design parameters, assumptions, and safety factors used in the design of the piers.
3. A North Carolina Professional Engineer shall provide the necessary structural design for the pier reinforcement.
4. All concrete to be 4,000 psi @ 28 days.
5. All voids to be filled with 3,000 P.S.I. concrete.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD CONCRETE PEIRS DETAIL

SCALE:	DETAIL #
Not To Scale	2 536.01
REVISION DATE: Oct., 2022	SHEET #: 1 of 1



ELEVATION



SEWER PIPELINE
(PT# 72461)



SEWER
FORCE MAIN
(PT# 72463)

SEWER MANHOLE
(PT# 72465)

NOTES:

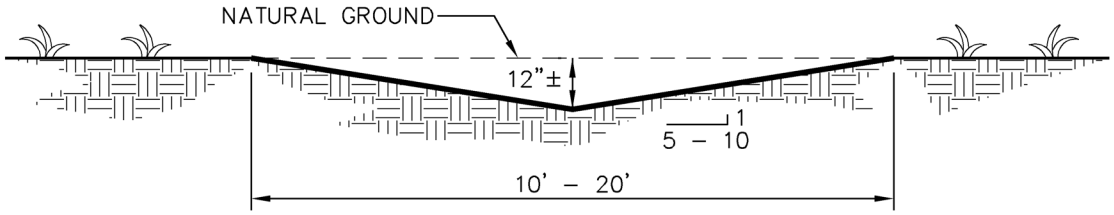
1. Utility marker post be Rhino TriView Flex Marking Post (PT# 70451 green for sewer) or approved equal. See detail above for decal designation.
2. At all manholes outside of asphalt, place manhole markers adjacent to manholes.

TOWN of CLAYTON

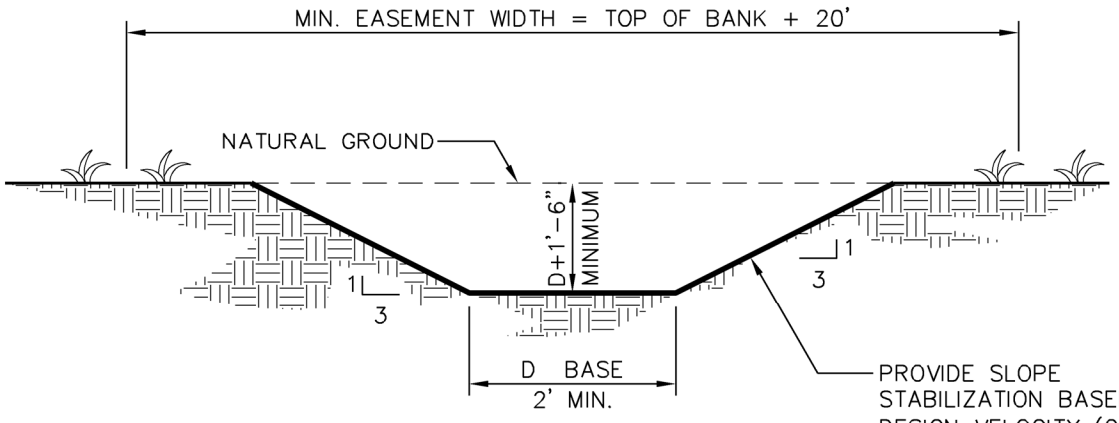
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

FIBERGLASS SEWER MARKER POST

SCALE:	DETAIL #
Not To Scale	2 539.01
REVISION DATE:	SHEET #:
Oct., 2022	1 of 1



SWALE DETAIL



CHANNEL DETAIL

NOTES:

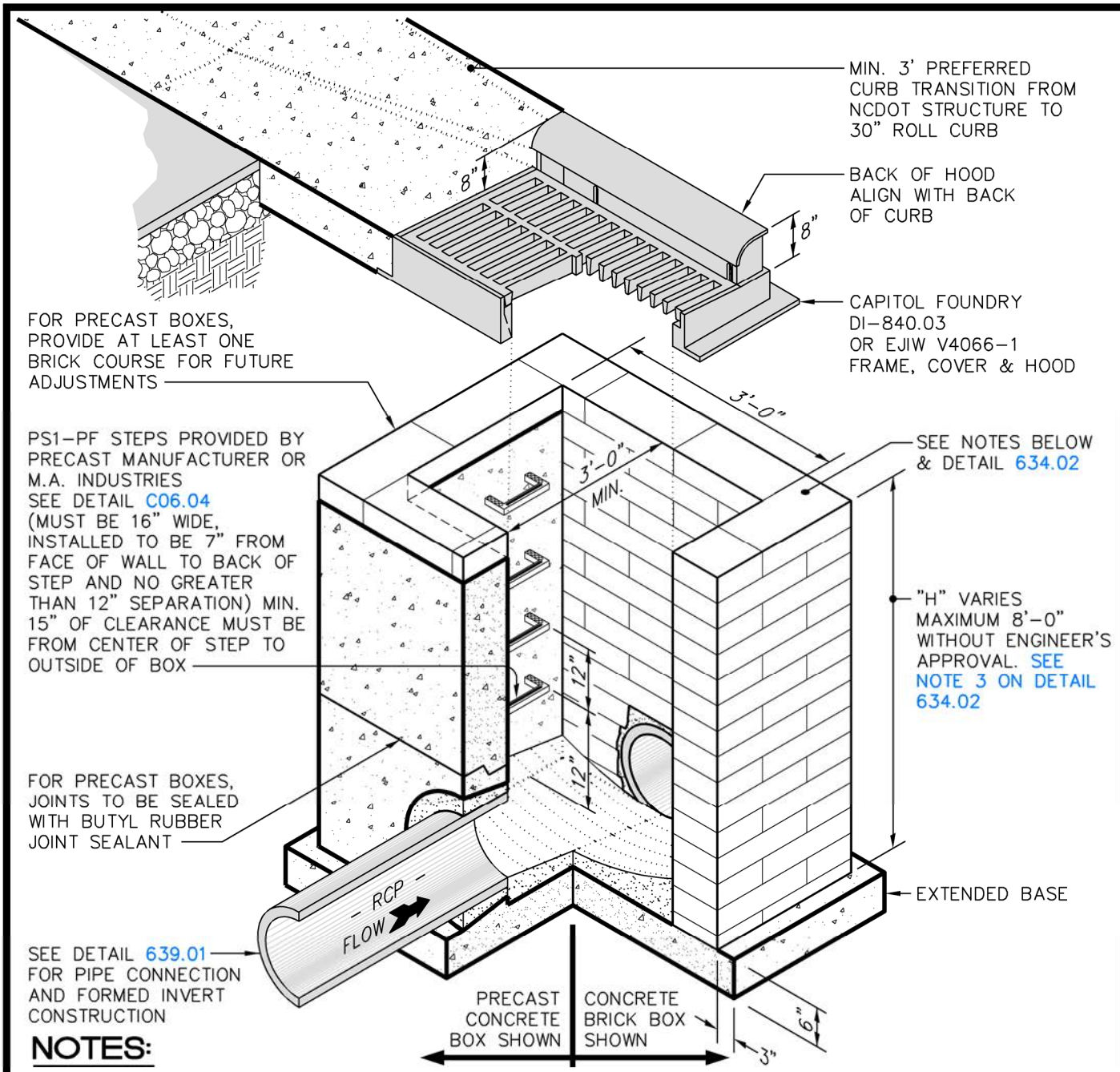
1. Minimum Longitudinal slope = 1.0%
2. Drainage channels shall be designed to carry the 10–year design storm.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL DRAINAGE CHANNELS

SCALE:	DETAIL #
Not To Scale	2631.02
REVISION DATE: December, 2022	SHEET #: 1 of 1



NOTES:

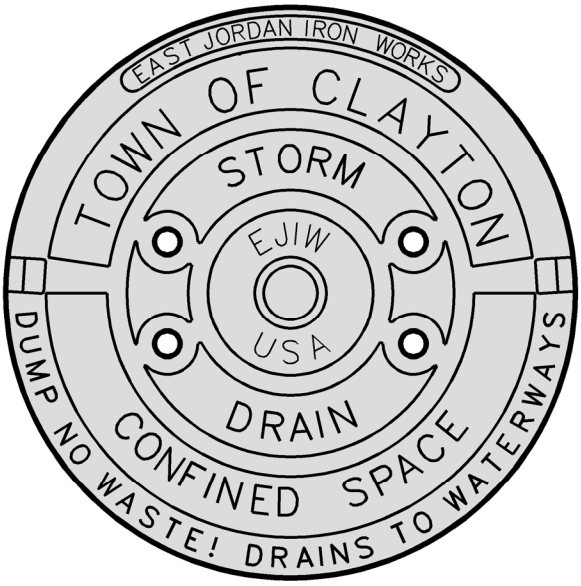
1. Use either concrete building brick – ASTM C55, grade N, type 1 or clay brick – ASTM C32, grade MS.
2. Mortar to be type M.
3. Concrete pipe to be class III
4. Precast boxes to conform to latest ASTM C-913
5. Precast boxes concrete strength to be a minimum 4,000 PSI at 28 days
6. See detail 634.02 for miscellaneous notes.
7. Top of precast box to be field adjusted usuing methods outlined in specifications.
8. This detail is a representation of the minimum standards for town of clayton combination curb opening inlet & catch basin. Refer to NCDOT Std. Details 840.00, 840.01, 840.02, 840.03, 840.45, & 840.46 for additional details and requirements.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL CATCH BASIN AND CURB INLET WITH HOOD

SCALE:	DETAIL #
Not To Scale	2 633.02
REVISION DATE: July, 2023	SHEET #: 1 of 1



DUMP NO WASTE ! EJIW	DRAINS TO WATERWAYS MADE IN USA

NCDOT 840.03 HOOD
(SEE DETAIL 633.02)

NOTES:

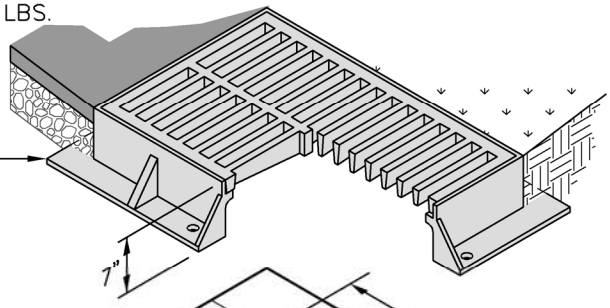
1. See detail C06.01 for additional manhole frame & cover detail.

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

STANDARD STORM DRAINAGE COVERS

SCALE: Not To Scale	DETAIL # 633.03
REVISION DATE: December, 2022	SHEET #: 1 of 1

EJCO V–4867–1 (44867261)
HEAVY DUTY FRAMES & COVER
COVER & FRAMES WEIGHT = 505 LBS.
WEIGHT MAY NOT DEVIATE BY MORE THAN –5.0%
383 IN.^{2} NET OPENING
(BOLT DOWN)



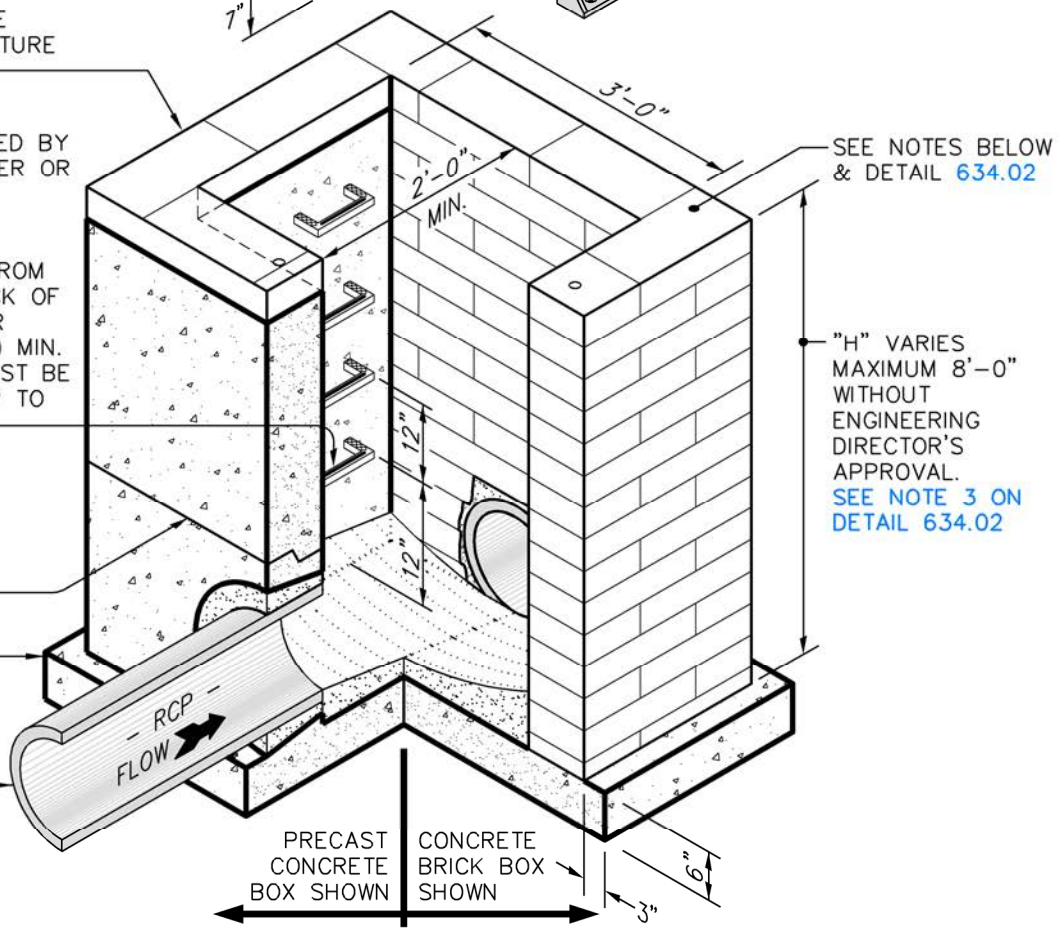
FOR PRECAST BOXES, PROVIDE AT LEAST ONE BRICK COURSE FOR FUTURE ADJUSTMENTS

PS1–PF STEPS PROVIDED BY PRECAST MANUFACTURER OR M.A. INDUSTRIES SEE DETAIL C06.04 (MUST BE 16" WIDE, INSTALLED TO BE 7" FROM FACE OF WALL TO BACK OF STEP AND NO GREATER THAN 12" SEPARATION) MIN. 15" OF CLEARANCE MUST BE FROM CENTER OF STEP TO OUTSIDE OF BOX

FOR PRECAST BOXES, JOINTS TO BE SEALED WITH BUTYL RUBBER JOINT SEALANT

EXTENDED BASE: FOOTING TO BE REINFORCED AS REQUIRED

SEE DETAIL 639.01 FOR PIPE CONNECTION AND FORMED INVERT CONSTRUCTION



SEE NOTES BELOW & DETAIL 634.02

"H" VARIES MAXIMUM 8'–0" WITHOUT ENGINEERING DIRECTOR'S APPROVAL. SEE NOTE 3 ON DETAIL 634.02

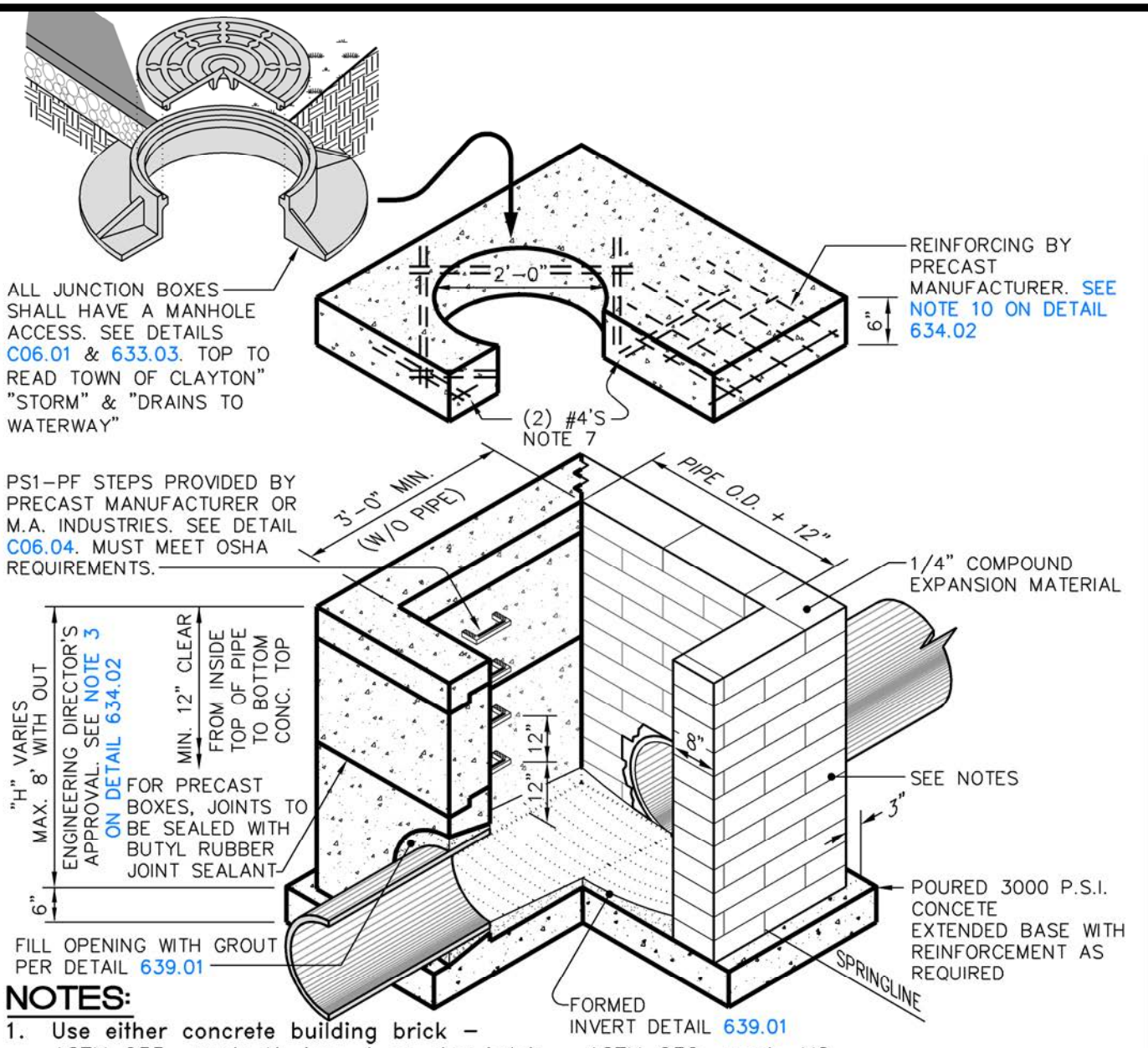
NOTES:

1. Use either concrete building brick – ASTM C55, grade N, type 1 or clay brick – ASTM C32, grade MS.
2. Mortar to be type M.
3. Concrete pipe to be class III RCP.
4. Precast boxes to conform to latest ASTM C–913.
5. Precast boxes concrete strength to be a minimum 4,000 PSI at 28 days.
6. See detail 634.02 for miscellaneous notes.
7. Top of precast box to be field adjusted usuing methods outlined in specifications.
8. This detail is a representation of the minimum standards for Town of Clayton combination curb opening inlet & catch basin. Refer to NCDOT Std. Details 840.00, 840.14, 840.15, 840.16, 840.45, 840.46, & 840.52 for additional details and requirements. Other DOT catch basin standard details may be used with the approval ot the Engineering Director. (i.e. In medians, ditches, & swales.)

TOWN of CLAYTON
USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL DROP INLET DETAIL

SCALE:	DETAIL #
Not To Scale	2 633.04
REVISION DATE:	SHEET #:
July, 2023	1 of 1



NOTES:

1. Use either concrete building brick – ASTM C55, grade N, type 1 or clay brick – ASTM C32, grade MS.
2. Mortar to be type M.
3. Concrete pipe to be class III.
4. Reinforcing shown is adequate for a maximum clear span of 4' based on 200 PSF live load plus weight of top (Non traffic). NCPE to design for loads & spans that are greater.
5. Precast boxes to conform to latest ASTM C-913.
6. All boxes over 3'-6" in depth shall be provided with steps (12" O.C.).
7. Provide 2' diameter opening and additional edge & diagonal reinforcing in concrete top at Manhole frame access.
8. Top of precast box to be field adjusted using methods outlined in specifications.
9. This detail is a representation of the minimum standards for Town of Clayton manhole junction box. Refer to NCDOT Std. Details 840.00, 840.31, 840.32, 840.34, 840.45, 840.46, 840.51, 840.52, & 840.53 for additional details and requirements.
10. See drainage structures notes on detail 634.02

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL JUNCTION BOX DETAIL

SCALE:	DETAIL #
Not To Scale	2 634.01
REVISION DATE: July, 2023	SHEET #: 1 of 1

Drainage Structures Notes:

Unless more stringent requirements are called for on referenced NCDOT standard details, the following shall apply:

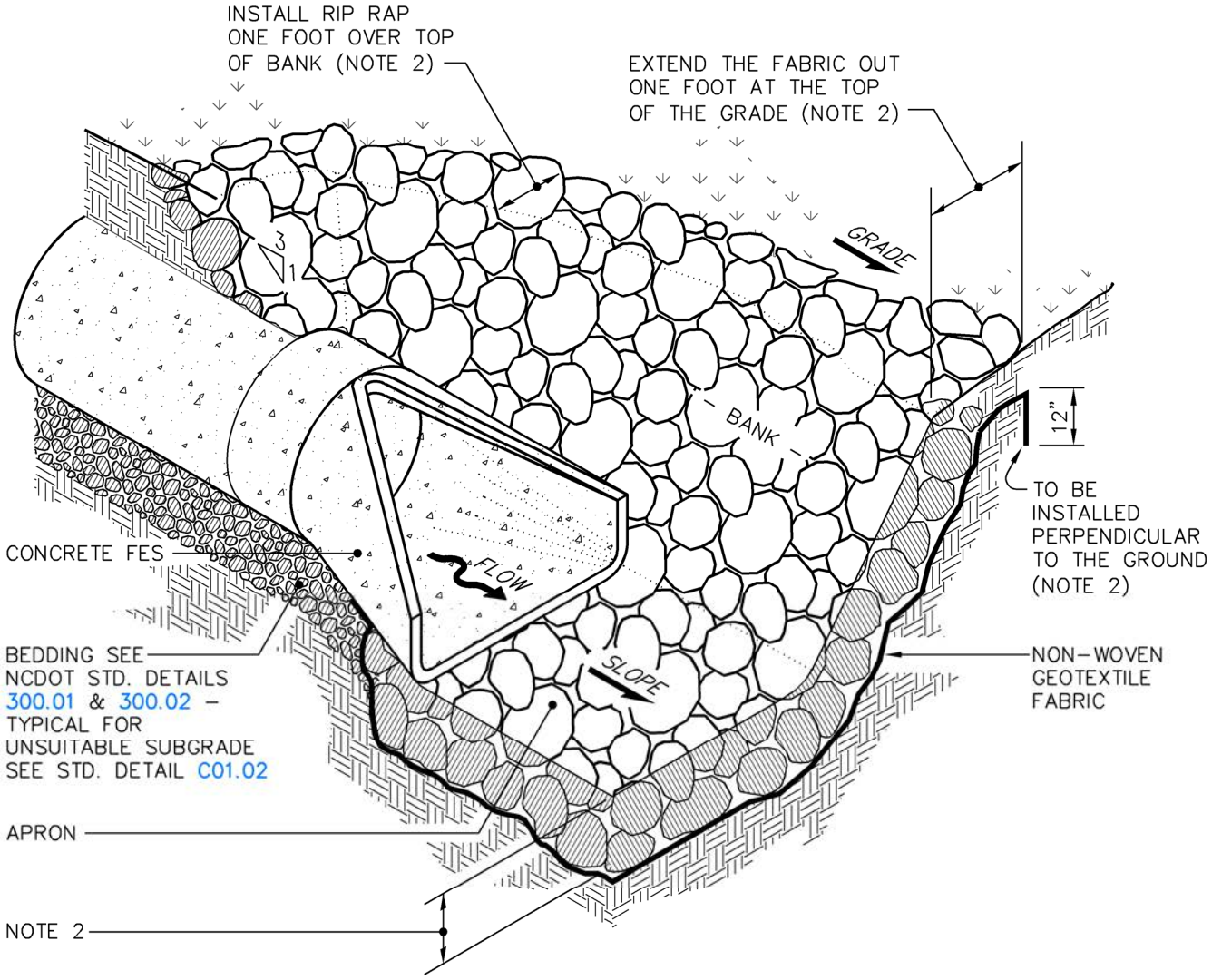
1. Boxes may be reinforced masonry, masonry, precast concrete or cast–in–place reinforced concrete.
2. Any non–standard box (non–standard meaning not shown in this manual), is to be designed by a NC Professional Engineer and approved by the Town of Clayton Engineering Director.
3. Masonry Boxes:
   a. Un–reinforced masonry boxes: The maximum height of an un–reinforced masonry drainage structure with 8" walls shall be limited to 8'–0" from invert of the outlet pipe to the top of the casting. Over 8'–0" in height, use 12" wall to 6'–0" from top of wall and 8" wall for remaining. Basins over 12' in total depth shall be designed by a NC Professional Engineer and approved by the Engineering Director. Four–inch walls are not allowed on drainage structures.
   b. Precast Boxes: For 8'–0" in height or less use 6" walls and bottom slab. Over 8'–0" to 16'–0" in height use 8" walls and bottom slab.
   c. Bottom slab on structures shall be reinforced as required when box depth exceeds 8 ft.
4. Steps are to be provided on all basins deeper than 36".
5. Steps are to be PS1–PF as manufactured by M. A. Industries or an approved equal. Locate on non–pipe walls. Steps shall meet OSHA requirements.
6. Mortar in masonry boxes is to be type M.
7. Clay brick structures are not allowed.
8. Concrete pipe is to be minimum class III.
9. Concrete building brick is to meet ASTM C–90 and must be NCDOT standard.
10. All cast–in–place or precast concrete drainage structures located in paved areas accessible to truck loadings to be designed to meet AASHTO HS 20–44 loading. See manufacturers details for wall, top and bottom thickness.
11. Inside of boxes shall allow for 6" of clearance on both sides of pipe. The dimension shown on the structures in this manual are minimum dimensions. For boxes with greater dimensions, either corbel walls, add a reinforced concrete top slab or lengthen box by adding additional grates & frames. Top and bottom slabs to be designed by NC Professional Engineer and approved by the Town of Clayton Engineering Director for H20 loading.
12. Maximum horizontal span of an 8" thick wall shall not exceed 8' for boxes of 8 feet or less in depth and 10 feet for boxes 12 feet or less in depth.
13. Concrete formed inverts are to be poured from a ready mix truck.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

DRAINAGE STRUCTURES NOTES

SCALE:	DETAIL #
Not To Scale	2634.02
REVISION DATE: December, 2022	SHEET #: 1 of 1



NOTES:

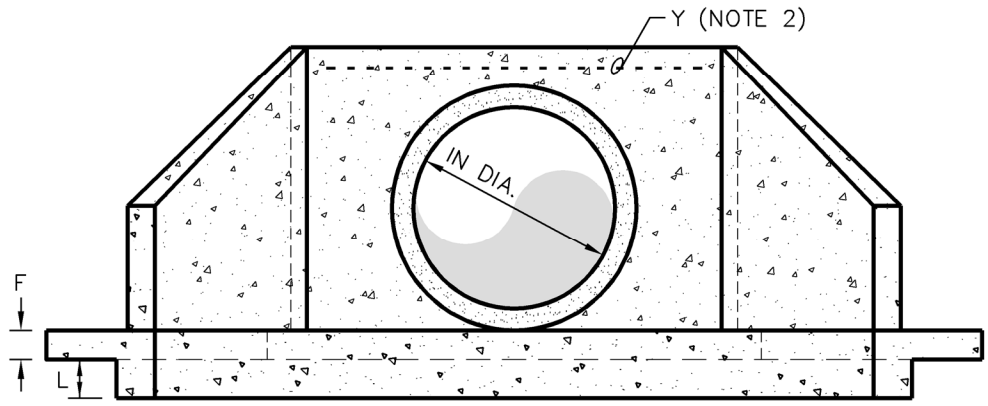
1. Initial course of rip rap to be laid in excavated bed at side slopes. Rip–rap is not to be laid on top of grade of side slopes.
2. Comply with NCDEQ Land Quality minimum requirements.
3. Submit pipe/ditch profile for review by Town.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

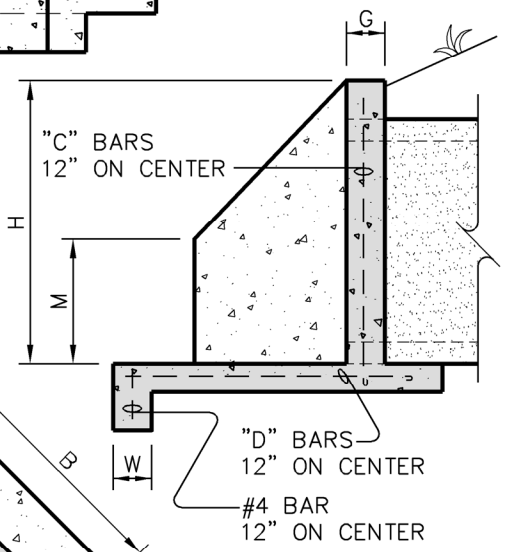
END OF PIPE TREATMENTS

SCALE:	DETAIL #
Not To Scale	2 636.01
REVISION DATE: December, 2022	SHEET #: 1 of 1

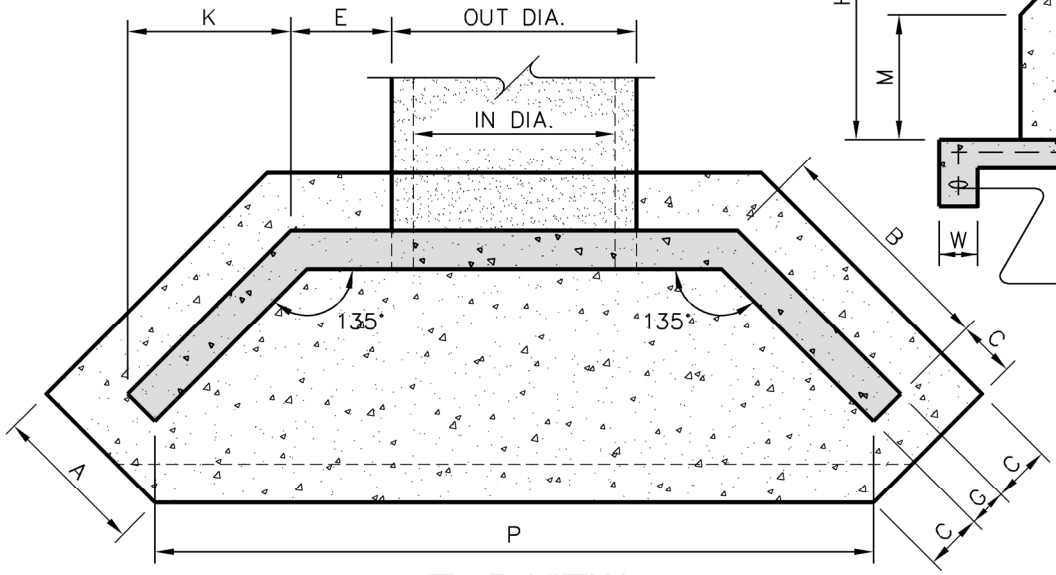


FRONT VIEW

SIDE VIEW



– ALL CONCRETE TO BE 4,000 PSI –



TOP VIEW

NOTES:

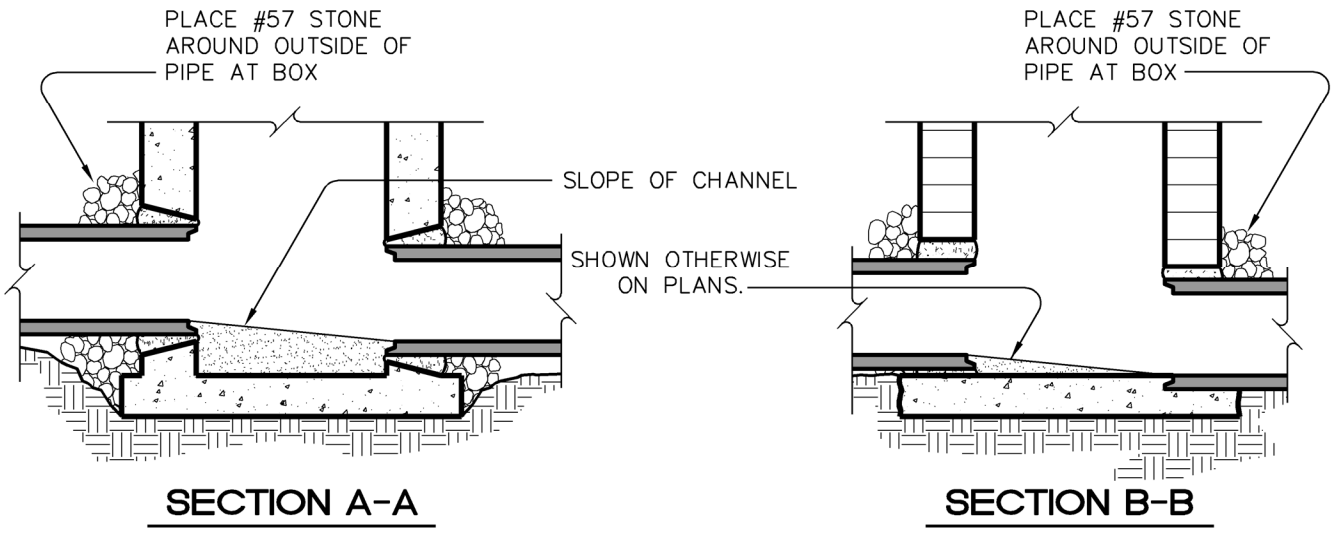
1. This detail is a representation of town of Clayton typical end/head wall for a single pipe at 90° to wall. Refer to NCDOT std. details 838.21, 838.22, 838.27, 838.28, 838.33, 838.34, 838.39, 838.40, 838.45, and 838.80. Other wall material & flare configurations may be used with approval of the Town of Clayton Engineering Director.
2. Pipes larger than 36" or with more than 1 pipe are required to have headwalls.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

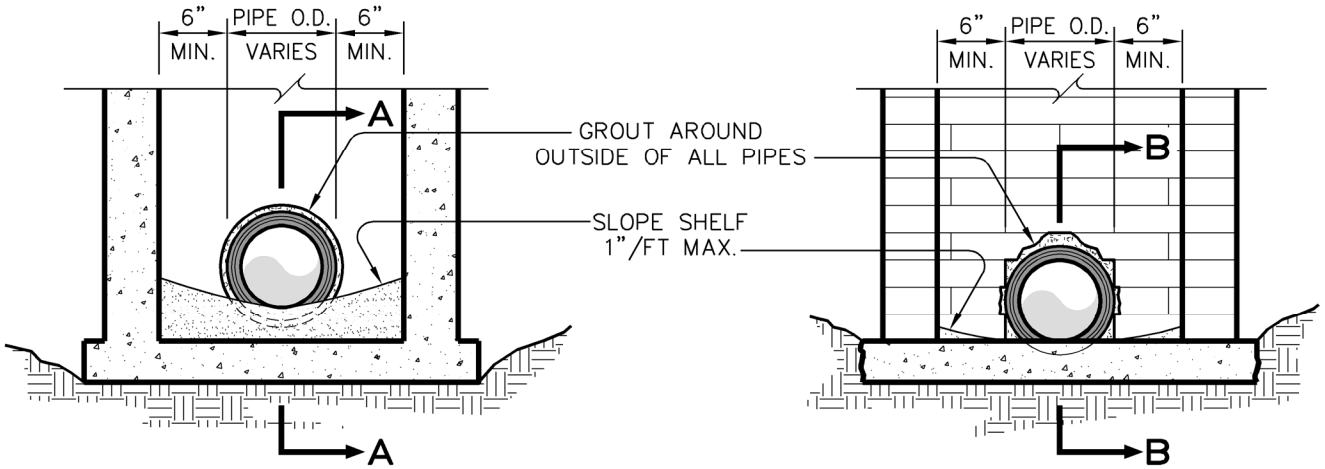
TYPICAL HEADWALL, WINGWALL, & SPLASH PAD

SCALE:	DETAIL #
Not To Scale	2 636.02
REVISION DATE: December, 2022	SHEET #: 1 of 1



SECTION A-A

SECTION B-B



PRECAST BOX

CONCRETE BRICK BOX

NOTES:

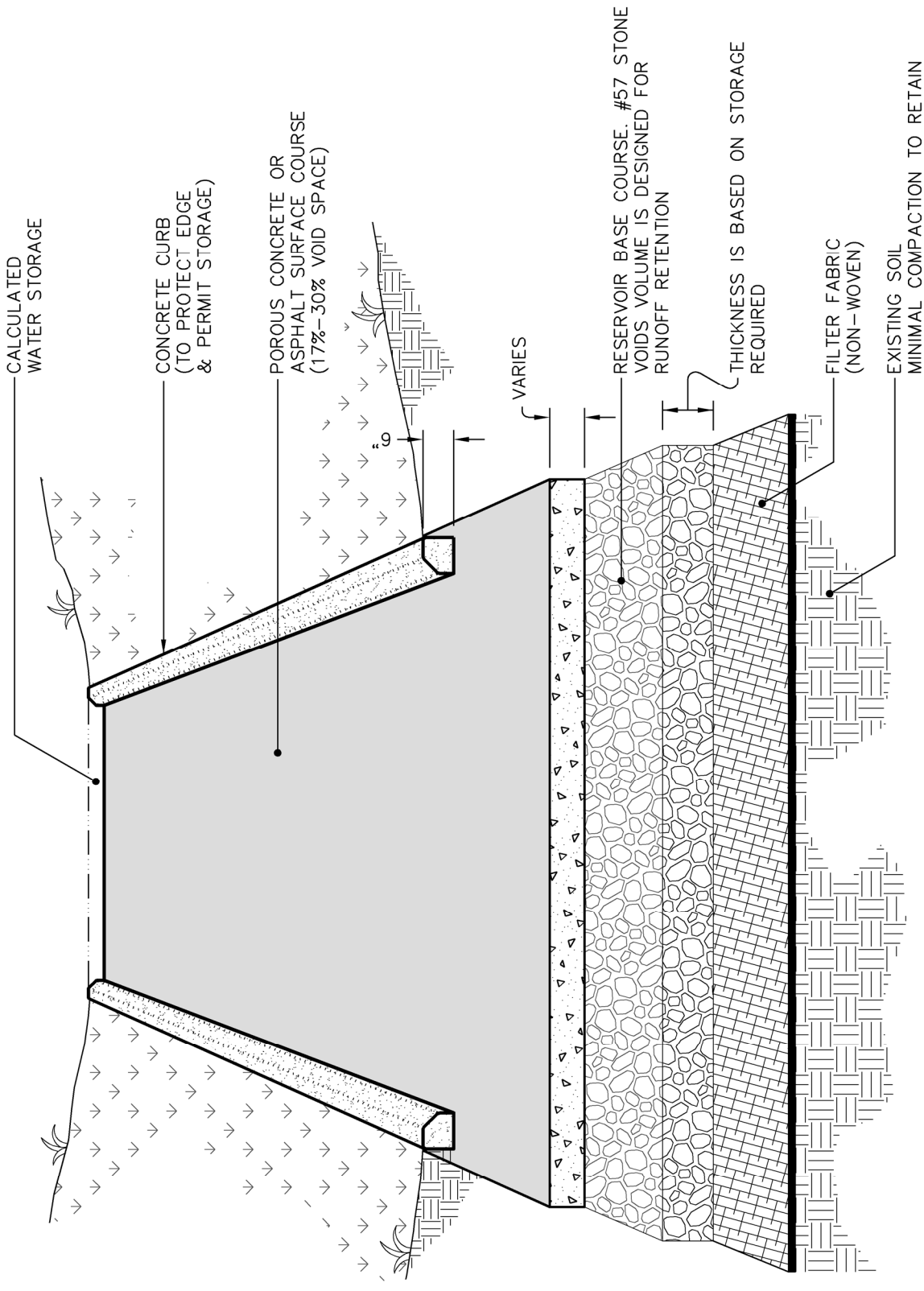
1. Invert to be a minimum of 3000 PSI at 28 days concrete, poured from a ready mix truck.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

PIPE CONSTRUCTION INTO BOX AND FORMED INVERT DETAIL

SCALE:	DETAIL #
Not To Scale	2 639.01
REVISION DATE: December, 2022	SHEET #: 1 of 1



NOTES:

1. Note that in any discrepancy between the NCDEQ and Town of Clayton requirements, the more stringent of the requirements apply.

TOWN of CLAYTON

USE WITH THE TOWN of CLAYTON STANDARD SPECIFICATIONS ONLY

TYPICAL SECTION of POROUS CONCRETE PAVEMENT

SCALE:	DETAIL #
Not To Scale	2644.01
REVISION DATE: December, 2022	SHEET #: 1 of 1