SECTION 450
UTILITY TRENCHES

451 Excavation and Preparation

A. Preparation

1. General Requirements

a) Trenching for pipelines (water, gravity sewer, and force main), shall be excavated to the required depth to permit the installation of the pipe (inclusive of pipes and structures) along the lines and grades shown on the construction drawings.

b) Prior to trenching for the construction of any utility mains or connections, the Contractor shall locate all existing utilities within the construction zone. This may include at a minimum contacting the North Carolina One Call Center at 811 or 1-800-632-4949. Where critical Town water and sewer utilities cannot be located by traditional means, specialized utility locating, such as vacuum excavation or ground penetrating radar (GPR) may be required to locate existing utilities before excavating.

c) In all cases where trenchless methods are planned to cross an existing utility corridor with water, sewer, force main, and/or other Town maintained pipelines, an SUE (subsurface utility exploration) services firm shall be contracted to verify the depths of existing utilities prior to boring.

d) The Contractor shall be responsible for implementing all required safety provisions for trenching in compliance with the Occupational Safety and Health Administration (OSHA) regulations and all other applicable safety requirements and procedures.

e) Refer to Section 500 for all Stormwater installations.

B. Trenching

1. Trench Dimensions

a) The minimum trench width at the top of the pipe shall be at least 16 inches greater than the outside diameter of the pipe, the maximum shall be 24 inches greater than the outside diameter. Rock shall be removed to a depth of at least 6 inches below the bottom of the pipe and the trench backfilled with suitable material.

b) Open trenches shall not exceed 100-ft.

c) All trenches shall be confined to the limits of the right-of-way or utility easement. Trenches in paved areas shall not be sloped.

d) All trenches shall be properly backfilled at the end of each working day.

2. Trench Protection

a) Wet gravity sewer trenches shall be stabilized with a base layer of #57 stone. The bottom of the trench shall be shaped to provide uniform support along the entire length of the pipeline. Severely unstable trench bottoms requiring undercut excavation shall receive a foundation support system for the pipeline designed by a registered Geotechnical Engineer licensed in the State of NC.

b) A space shall be excavated at each bell to provide ample space to join the pipes with no misalignment.

c) The Contractor shall take all necessary measures to prevent water from entering the trench.

3. Dewatering

a) The ground adjacent to the excavation shall be graded to prevent surface water from entering the trench. The Contractor will, at his expense, remove by pumping or other means approved by the Town, any water accumulated in the trench and shall keep the trench dewatered until bedding and pipe laying are complete. When water is pumped from the trench, the discharge shall follow natural drainage channels. Proper erosion control measures shall be employed. Direct discharge into stream is not permissible.

b) In gravity sewer trenches where water is present or where dewatering is required, the trench bottom shall be undercut and stabilized with No. 57 or No. 67 stone, having a minimum depth of 8-inches.

452 Pipe Laying and Backfilling

A. General Requirements

1. Embedment Material

a) Bedding and embedment material classifications shall be defined as follows:

1) CLASS I - Angular, (1/4 to 1-1/2 inch) graded stone, including a number of fill materials that have regional significance such

as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.

2) CLASS II - Coarse sands and gravels with maximum particle size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.

3) CLASS III - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures, Soil Types GM, GC, SM, and SC are included in this class.

4) CLASS IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials shall not be used for embedment.

b) Class I foundation material consisting of ¼-inch to 1½ -inch graded stone shall be required in addition to standard bedding and embedment for all sewer installations, regardless of pipe material, when the trench bottom is unstable due to water, rock, infiltration or soil type.

c) All bedding, embedment and backfill materials shall be compacted to a minimum of 95% Standard Proctor density regardless of material. In instances where compliance with compaction requirements is questionable as determined by the Town, testing shall be provided by the Contractor and a reputable licensed Geotechnical Engineer to verify compliance.

d) The minimum trench width shall be one pipe diameter plus 8 inches on each side of the pipe, with a maximum of 12 inches on each side of the pipe.

e) In any area where the pipe will be installed below existing or future ground water levels or where the trench could be subject to inundation, additional Class I material shall be used for bedding.

f) If hydraulic jack shoring is utilized for trench walls, it shall be restricted to the area just above the top of the pipe. This will ensure the embedment materials and pipe will not be disturbed when the shoring is removed.

2. Pipe Laying

a) Open ends of pipe shall be plugged when pipe laying is not in progress to prevent trench water, soil, and debris from entering.

b) All pipe shall be laid in accordance with the manufacturer's recommendations, all applicable Town Standards, Specifications and Details, and in accordance with construction drawings.

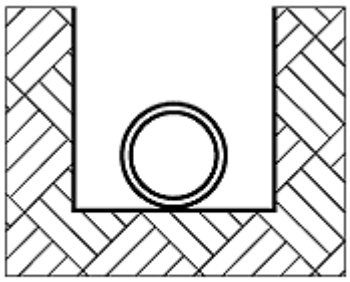
c) Pipe laying shall be accomplished in a manner and with the required resources to provide a properly aligned and sealed pipeline and joints.

d) Pipe deflection limits shall not be exceeded in accordance with manufacturer requirements.

e) All gravity mains shall be installed beginning with the downhill section at the lowest elevation, and advanced upgrade to the terminus of the main. All bell ends shall be oriented facing the uphill direction.

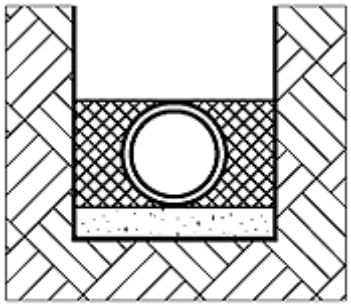
f) Laying conditions shall be defined as follows:

Type 1:
Flat Bottom Trench with Pipe Resting on Stable Undisturbed Earth. Unstable conditions such as wet trench bottoms, intermediate rock layering, partially weathered rock, and other unsuitable soil conditions shall require utilizing more stringent laying conditions. At a minimum, Type 4 laying condition shall be utilized with a minimum of 4-inches of bedding to overcome unstable conditions. For severe unstable soil conditions, undercut excavation and an engineer designed foundation plan shall be provided prior to pipeline installation.



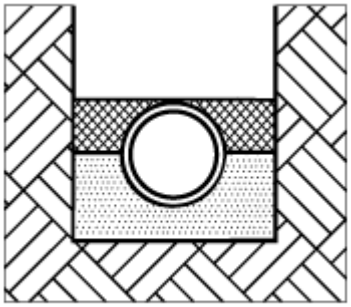
Type 1*

Type 4:
Pipe bedded in Class 1 material, No. 67 or No 57 crushed stone to a depth of 1/8 pipe diameter or a minimum of 6-inches. Embedment material, consisting of Class 1, Class 2 or Class 3 materials, shall be compacted greater than 95% Proctor to the top of the pipe. Careful attention must be allocated to compacting embedment material under the bottom edges of the pipe.



Type 4

Type 5:
Pipe bedded in Class 1 material, No. 67 or No. 57 crushed stone to the center of the pipe and extending a minimum of 6-inches under the pipe. Granular or select embedment, consisting of Class 1 or Class 2 materials, compacted to greater than 95% Proctor installed to the top of the pipe.



Type 5

g) For installations below the water table, a single layer of engineering fabric shall be installed between the pipe and trench floor/trench wall. The fabric shall fully encapsulate the waterline, bedding, and embedment material with a minimum of 12-inch overlap at the top of the embedment material.

3. DIP Specific Installation Requirements

a) Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.

b) Pipe shall be installed at laying conditions as specified herein and identified by the plan drawings. Laying conditions for ductile iron pipe shall be as described in AWWA C151 and the Ductile Iron Pipe Research Association.

4. PVC Specific Installation Requirements

The installation of PVC Pipe shall satisfy the requirements of the manufacturer, and/or the following, whichever is more stringent:

a) For PVC pipe, the pipe shall be produced with bell and spigot end construction. Joining shall be accomplished by rubber gasket in accordance with manufacturer's recommendation. Flexible watertight elastomeric seals in accordance with ASTM D3212-1 may also be used. Each pipe length shall be clearly marked with information including pipe size, profile number and class number.

b) Installation of PVC pipe shall follow the recommendations of ASTM D-2321 "Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications". For PVC pipe installation, bedding and embedment material shall be Class I, typically No. 67 or No. 57 washed stone. Bedding and embedment materials for PVC gravity sewers other than No. 67 or No. 57 washed stone shall be approved by the Town of Apex prior to use.

c) Bedding for gravity sewer shall consist of minimum 4-inches of No. 67 or No. 57 stone installed under the pipe (Type 4). Embedment shall extend to the top of the pipe. Bedding and embedment shall be compacted to 95% standard proctor density. Careful attention shall be placed on compacting embedment under the haunches of the pipe to prevent any potential voids.

d) The bedding and embedment materials shall be in accordance with ASTM D-2321. The embedment materials shall be installed from trench wall to trench wall.

e) The maximum allowable deflection after installation shall BE LESS THAN 5% for PVC pipe.

f) All PVC pipe shall be stored properly to prevent UV damage prior to installation. Any PVC pipe with visible fading caused by UV radiation from sunlight shall be rejected.

g) All PVC pipe shall be free from nicks, scratches and gouges at the time of installation. Such defects can impact the strength of PVC pipe and all pipes with visible gouges shall be rejected.

5. Backfill

a) Backfill material shall be free from construction material, frozen material, organic material, or unstable material. Backfill with a high clay content or high shrink-swell potential that cannot meet compaction requirements shall be deemed unsuitable and replaced.

b) Backfill materials that have been allowed to become saturated or with moisture contents non-conducive to meeting compaction requirements shall be deemed unsuitable and replaced.

c) When original excavated materials have been deemed unsuitable, granular material must be imported to the site to backfill utility trenches and meet compaction requirements. The following materials shall be acceptable forms of granular backfill: aggregate base course, soil type base course, select backfill material, sand or screenings in accordance with NCDOT Specifications.

d) In all open utility trenches, backfill shall be compacted to 95% maximum dry density as measured by AASHTO method T99. The Contractor shall be responsible for verifying that compaction requirements have been met or exceeded by providing soils testing data from an approved Geotechnical Firm. The soil test results shall be certified by a licensed Geotechnical Engineer.

e) Backfill for utility trenches shall be placed in lifts of uncompacted soil in accordance with the standard detail and compacted with a mechanical tamp before placing additional layers.

f) No rocks, boulders, or stones shall be included in the backfill material for at least 2 feet above the top of the pipe. In traffic areas, the final backfill shall be placed and compacted in 6-inch layers. Backfill shall be of such density as to ensure no settlement of the trench.

g) A compaction test shall be performed every 1,000 feet for utility installations, with a minimum of one test per utility by a licensed Professional Engineer and shall be coordinated and submitted at the Contractor’s expense. The location of tests shall be determined by the Town. The Town may request

additional testing. Additional tests that are deemed passing will be at the Town's expense, failed tests shall be paid for by the Contractor. Organic material shall not be permitted for backfill.

h) Should any water line trench exhibit settlement, the Contractor shall correct the deficiency to the complete satisfaction of the Town. Where a utility line is in or crosses existing State roads or other public roads, the backfill shall be compacted to at least 95% standard density as measured by AASHTO Method T-99, or in accordance with NCDOT specifications, whichever is more stringent.

i) For permitted open-cut utility installations and/or tie-ins, the Town may require that "flowable fill" be used for backfill material. If required, 1 foot of approved natural backfill material shall be compacted over the main per Apex Specifications, the remaining excavated trench shall be backfilled with "flowable fill". Within seven (7) days after the excavation has been filled, the open-cut area shall be repaired per the Standard Detail.

6. Pipe Identification and Marking

a) Marking Tape

1) Installation: Marking tape shall be installed continuously and longitudinally along all mains and services for new construction and for any repair or retrofit construction using open trench methods. For service connections, the marking tape shall extend from the main line to the meter or first cleanout off the main/manhole. Marking tape shall be installed directly above the center of the pipe and at least 18-inches deep from final grade to a maximum depth of 24-inches below final grade.

2) Specifications: The marking tape shall be made of polyethylene (or approved equivalent) material, 6-inches wide and a minimum of 6 millimeters thick. The marking tape shall have detectable markers embedded in the tape and spaced adequately to provide continuous detection along the tape from above the buried pipe at final grade. The tape color shall be in accordance with the utility being installed:

a. Blue for water and shall be marked with words "CAUTION WATER LINE BURIED BELOW" (or an approved equivalent wording).

b. Green for gravity sewer and force mains and shall be marked with words "CAUTION SEWER LINE BURIED BELOW" (or an approved equivalent wording).

3) The wording shall be repetitive along the full length of the tape.

b) Tracer Wire

1) Tracer wire shall be installed with all water and forcemain piping and color coded blue for water or green for forcemain.

2) Tracer wire access must be provided utilizing an approved grade level/in-ground trace wire access box, located in line over the utility to be located. The grade level/in-ground trace wire access box shall be delineated using a concrete marker with a brass plate per Standard Detail.

3) All tracer wire and trace wire products shall be domestically manufactured in the U.S.A.

4) All tracer wire shall have HDPE insulation intended for direct bury, blue in color for water and green in color for sewer, coated per APWA standard.

5) Tracer wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.

6) Wire installation method requirements are:

a. Open Trench - Trace wire shall be #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 mil HDPE insulation thickness.

b. Directional Drilling/Boring - Trace wire shall be #12 AWG Copper Clad Steel, Extra High Strength with minimum 1,150 lb. break load, with minimum 30 mil HDPE insulation thickness.

c. Pipe Bursting/Slip Lining - Trace wire shall be 7 x 7 Stranded Copper Clad Steel, Extreme Strength with 4,700 lb. break load, with minimum 50 ml HDPE insulation thickness.

7) Direct bury wire connectors – shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground trace wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to

prevent any uninsulated wire exposure.

8) Non locking friction fit, twist on or taped connectors are prohibited.

9) Termination and access requirements as follows:

    a. Tracer wire access points are to be no more than 500' apart.

    b. All tracer wire termination points must utilize an approved tracer wire access box (grade level/in-ground access box as applicable), per Standard Detail.

    c. All grade level/in-ground access boxes shall be appropriately identified with "water" or "sewer" cast into the cap, per Standard Detail.

    d. A minimum of 2 ft. of excess/slack wire is required in all trace wire access boxes after meeting final elevation.

    e. All tracer wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the tracer wire connection and the terminal for the grounding anode wire connection.

    f. Grounding anode wire shall be connected to the identified (or bottom) terminal on all access boxes.

10) Test Stations shall be 2 ½" diameter with 2 terminals, green and be equivalent to Bingham and Taylor model P225 SR or Copperhead model LD12 TP and shall be installed in a valve box per Standard Detail.

11) A grounding anode shall be installed at each test station equivalents to Copperhead model ANO-1005.

c) Marker Tape and Tracer Wire Testing

1) Testing of the marker tape and tracer wire shall be performed by the Contractor at the completion of the project to assure they are all working properly. It is the Contractor's responsibility to provide the necessary equipment to perform all testing. Any defective, missing, or otherwise non-locatable units shall be replaced.

453 Pavement Repairs

A. Open Trench Pavement Repair

1. General Requirements

a) All pavement cuts shall be repaired within a maximum of three (3) days from the date the cut is made. If conditions do not permit a permanent repair within the given time limit, permission to make a temporary repair must be obtained from the Town.

b) Pavement repairs shall be made in accordance with the Details.

c) All asphalt pavement utilized to repair open trenches shall comply with all applicable Town of Apex asphalt pavement material and installation Specifications.

d) All pavement patches shall be provided in such a manner that a uniform and smooth driving surface free of depressions and/or bumps is obtained. Pavement patches not meeting this standard shall be milled and replaced.

e) All utility mains installed by open cut across Town or NCDOT roadways shall include steel encasement, sized in accordance with tables found in this specification.

454 Trenchless Pipe Installation

A. Design

1. General Requirements

a) All utility crossings within Town streets shall be made by trenchless methods. State maintained streets within the Town ETJ should also be crossed using trenchless methods. In cases where utility conflicts, rock, or other obstructions prevent trenchless crossings, the Town may consider approving other methods.

b) The preferred trenchless method shall be auger boring. Alternate trenchless methods including microtunneling, guided boring, conventional tunneling, horizontal directional drilling or hand tunneling may be approved after thorough evaluation by the Water Resources Department.

c) In addition to meeting or exceeding all Town requirements, all trenchless crossings shall be approved by and meet the requirements of all controlling legal authorities, such as NCDOT, Norfolk Southern Railway, CSX Corporation, Colonial Pipeline, Cardinal Pipeline, and Dixie Pipeline.

d) Direct bores may be made without a casing pipe on pipelines 6-inches in diameter and smaller.

e) Encasement pipe shall be installed with all trenchless construction methods (excluding horizontal directional drilling when it is approved and as noted above). There shall be a minimum cover of 4-ft between the pavement subgrade and the top of the casing pipe. Under no circumstances shall the pavement subgrade be disturbed.

f) Permanent easements shall be provided at all trenchless pits to allow for future access to casing pipes.

B. Materials

1. Encasement Pipe

a) Encasement pipe shall be new and manufactured of grade 'B' steel with minimum yield strength of 35,000-psi in accordance with ASTM A139 and A283.

b) All casing pipe shall have machine cut, bevel ends that are perpendicular to the longitudinal axis of the casing. Ends shall be plumb and welded without the use of filler material.

c) Size and minimum wall thickness of smooth wall or spiral welded steel encasement pipe shall be as shown in the below table. Actual wall thicknesses shall be determined by the casing installer based on their evaluation of the required forces to be exerted on the casing when it is installed.

Minimum Wall Thickness of Steel Encasement Pipe

Encasement Pipe Outside Diameter *(inches)*	Minimum Wall Thickness *(inches)*
14	0.375
16	0.375
18	0.375
20	0.375
24	0.375
26	0.500
28	0.500
30	0.500
36	0.625
42	0.625
48	0.750
54	0.750
60	0.750
66	0.750

d) Encasement pipe installed for railroad bores shall meet the requirements of the American Railway Engineering Association (AREA) for boring under railroads.

e) Encasement pipe shall be sized in accordance with the standard detail.

2. Casing Pipe Spacers and End Closures

a) The carrier pipe shall rest on steel pipe alignment spacers. The spacers shall have either a bituminous or epoxy coating. A minimum of 3 steel spacers per joint shall be required on carrier pipe less than 36-inches. Carrier pipe greater than or equal to 36-inches shall have a fourth spacer. The steel spacers shall be located evenly along the carrier pipe alignment in such a manner that each spacer supports the same unit weight of carrier main. The spacing interval of the steel spacers shall assure the necessary grade, clearance, and support of the carrier main. The spacers shall be manufactured for the specific carrier pipe and casing pipe diameters being used such that the risers do not allow the pipe to float within the casing.

b) In cases where the encasement pipe is installed in within the easement of facilities with stray current, such as gas lines, high voltage power transmission lines, petroleum lines, railroad tracks, etc., the spacers shall be a composite material such as an ultra-high molecular weight polyethylene plastic to prevent transmitting the stray current to the carrier pipe.

c) In cases where PVC carrier pipe is installed in an encasement pipe, steel spiders with soft contact surfaces rated for use with PVC pipe shall be used.

d) The carrier pipe bells shall not be allowed to contact the interior of the encasement pipe under any circumstances.

e) No blocks or temporary spacers shall be wedged between the carrier pipe and the top of the encasement pipe.

f) The ends of the encasement pipe shall be sealed using solid 8-inch bricks and a non-shrink grout.

g) A 2-inch galvanized vent pipe shall be provided on the upper end of the casing on all stream and railroad crossings.

3. Carrier Pipe

a) All carrier pipe shall be manufacturer provided restrained joint ductile iron pipe except for sewer force mains in which restrained PVC C900 may be utilized in compliance with Section 0800.

4. Polyethylene (PE) Pressure Pipe

a) Pipe shall be certified and listed for potable water distribution products in accordance with NSF 61 and bear the NSF seal on each section of pipe.

b) Outside diameter shall conform with ductile-iron pipe.

c) Material for pipe manufacturing shall be PE 3408 high density polyethylene (HDPE) meeting ASTM D3350 cell classification of 345444C.

d) Pipe shall be pressure class PC 250 with a standard dimension ratio (DR) of 9.

e) Fittings shall be made of material meeting the same requirements as the pipe.

5. Fusible Polyvinylchloride Pipe

a) Fusible polyvinylchloride pipe shall conform to AWWA C900. Testing shall be in accordance with AWWA standards.

b) Pipe shall be DIPS standard dimensions with a minimum pressure rating of 235 psi (DR18) and the size as indicated on the Drawings.

c) Piping shall be made from a PVC compound conforming to cell classification 12454 per ASTM D1784.

d) Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

e) Fusible polyvinylchloride pipe shall be manufactured in standard 40 foot nominal lengths.

f) Fusible polyvinylchloride pipe shall be blue in color for water use or green in color for wastewater use.

g) Pipe generally shall be marked per industry standards, and shall include as a minimum:

1. Nominal pipe size
2. PVC
3. Dimension Ratio
4. Pipe legend or stiffness designation, or AWWA pressure class
5. AWWA Standard designation number
6. Extrusion production-record code
7. Trademark or trade name
8. Cell Classification 12454 and/or PVC material code 1120 may also be included.

h) Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

C. Installation

1. General Requirements

a) As the trenchless operation progresses, each new section of encasement pipe shall be joined using full penetration seal welds prior to installation of the casing. Joints shall be electric-fusion welded by operators qualified in accordance with the American Welding Society's standard procedure for arc welds. The welds shall be capable of transmitting all thrust and other loads across the joints.

b) If voids are encountered while installing encasement pipe thirty (30) inches and larger, 2-inch or larger grout holes shall be installed at ten (10) foot centers in the top section of the encasement pipe. The grout

holes shall be used to fill the void spaces with 1:3 Portland cement grout at sufficient pressure to prevent settlement of the roadway, unless NCDOT approval stipulates otherwise. Other grout mixtures may be submitted for approval.

c) In the event that an obstruction is encountered during the trenchless operations, the equipment shall be withdrawn. The pipe shall be cut off, capped, and filled with 1:3 Portland cement grout at a sufficient pressure to fill all voids before moving to another boring site.

d) Restrained joint ductile iron carrier pipe shall be pulled into the casing pipe. Pipe lined with Protecto 401 for sewer application shall never be pushed into a casing.

2. Settlement Surveying

a) For all trenchless operations of 100-ft or more, the ground surface elevations shall be recorded prior to beginning work.

1. At a minimum, survey points shall be identified with a nail or hub located as follows:

i. Road crossings: Centerline and each shoulder/curb

ii. Utility and Pipeline Crossings: Directly above and 10-ft each side of the crossing

iii. All locations: Points shall not exceed 50-ft spacing

2. Elevations at each point shall be recorded with an accuracy of 0.01-ft.

b) Settlement observations shall be made each day until the pipe/casing is fully installed. Once installed, observations shall be made weekly for a period of at least four (4) weeks.

c) Readings shall be reported to the Infrastructure Inspector.

d) In the case of observed settlement, the monitoring points and observation frequency shall be increased as determined by the Town.

3. Horizontal Directional Drilling

a) General

1. Drill pilot hole along the path shown on the Drawings to the following tolerances:

    a. Vertical Location - Plus or minus 1 foot

    b. Horizontal Location - Plus or minus 3 feet.

2. At the completion of the pilot hole drilling, provide a tabulation of coordinates referenced to the drilled entry point which accurately describes the location of the pilot hole.

3. Perform reaming diameter to 1.25 to 1.5 times the outside diameter of the pipe being installed. Prepare pipe to facilitate connection to the remainder of the pipeline being installed.

4. Use care to protect the pipe from scarring, gouging, or excessive abrasion.

5. Method of connection between HDD pipe and other pipe materials shall be as indicated on the Drawings.

6. Pipe shall be deflected within the tolerances as provided by the pipe manufacturer.

7. For drills under structural conditions (i.e., roadways), perform reaming diameter to 2 inches maximum greater than outside diameter of the pipe being installed. If larger size is necessary, provide statement from North Carolina Professional Engineer stating that “an overbore in excess of 2-inches will arch and no damage will be done to pavement or sub-grade”.

b) Fusible Polyvinylchloride (FPVC) pipe

1. General

    a. Installation guidelines from the pipe supplier shall be followed for all installations.

    b. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius guidelines.

2. Handling and Storage

    a. Pipe shall be offloaded, loaded, installed, handled, stored and stacked per the pipe supplier's guidelines. These guidelines include compliance with the minimum recommended bend radius and maximum safe pull force for the specific pipe being used.

3. Fusion Joints

    a. Fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The fusion technician shall follow the pipe supplier's guidelines for this procedure. All fusion joints shall be completed as described in this specification.

4. Fusion Process

    a. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.

    b. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier.

    c. Pipe supplier's procedures shall be followed at all times during fusion operations.

5. Installation

    a. Once installed according to manufacturer's requirements, the contractor shall make connections to the open cut pipe by means of mechanical joint fittings, taking care to correct horizontal or vertical alignment with the fittings rather than the Fusible PVC.

455 External Corrosion Protection

1. General Requirements

a) External corrosion can occur at an accelerated rate in metallic pipelines such as steel and ductile iron when they are installed in aggressive soils

or when they are installed near other structures or utilities that carry impressed currents. Such facilities that typically utilize impressed current cathodic protection are gas pipelines, such as owned by Colonial Pipeline, Cardinal Pipeline and Dixie Pipeline. Other potential sources that may create stray currents that contribute to accelerated pipeline corrosion are high voltage power transmission lines and railroad crossings.

b) In cases where metallic steel and ductile iron pipelines or encasement pipes are planned for installation in close proximity to any potential sources of stray current or aggressive soils, zinc coated pipe shall be specified and a field analysis consisting of stray current evaluation and soil testing shall be conducted by an experienced technician, as certified by the National Association of Corrosion Engineers, (NACE), to determine the potential for external corrosion and the need for additional protection measures. In cases where stray current conditions and/or aggressive soils are prevalent, a corrosion specialist certified by the NACE or other applicable certification board shall be consulted regarding the design of pipeline protection measures.

c) At a minimum, all stray current protection systems should include bonded joints and sacrificial anodes with a 50-year or longer design life and test facilities in lieu of polyethylene encasement, unless otherwise approved by the Town of Apex. The cathodic protection element of the pipeline design package shall be sealed by Professional Engineer licensed in the State of NC.

d) Full impressed current cathodic protection shall only be utilized when extreme corrosion potential has been proven and/or as otherwise directed by the Water Resources Department and the certified corrosion engineer of record.

e) When field conditions require cathodic protection, the Engineer must provide alignment showing no practical alternative, as well as calculations and design of cathodic protection system. Design shall include, but not be limited to, the provisions of all instruments, anodes, wiring, appurtenant equipment, and accessories and must be specifically called out on the drawings for a complete and operating cathodic protection system.

f) All ductile iron pipe that is installed within 60 feet of any gas line shall be wrapped with a dual layer of 8 mil polyethylene encasement. The dual polyethylene encasement shall meet AWWA C105 requirements for dielectric strength of 800 volts per mil (12,800 volts per a 16-mils thick dual polyethylene system) to shield the ductile pipe from elevated stray currents.

g) Perpendicular crossings of gas lines/easements with ductile iron pipe shall include a dual layer of 8 mil polyethylene encasement across the entire easement width plus a distance of 60 feet on each side of the easement.

456 Rock Excavation

1. General Requirements

a) Rock shall be defined as that solid material that cannot be excavated, in the opinion of the Water Resources Director, by any means other than drilling and blasting, drilling and wedging, or boulders and broken concrete exceeding ½ cubic yard in volume. Rock shall be excavated to the same limits as earth excavation except that the trench shall be made 6- inches lower than the outer bottom of the pipe. This 6-inches shall be refilled with 6-inches of #67 stone and thoroughly compacted to the sub-grade level. All blasting shall be done under the supervision of the Town Inspector or Engineer and subject to all applicable regulations. The Town reserves the right to require the removal of rock by means other than blasting where any pipe or conduit is either too close to or so situated with respect to the blasting as to make blasting hazardous. Rock taken from the ditch shall immediately be hauled away and disposed of by the contractor.

b) Blasting procedures shall conform to all applicable local, state and federal laws and ordinances. A blasting permit shall be obtained from the Town's Fire Marshal's Office, prior to any blasting. The application shall be obtained 24-hours before any blasting takes place, and the Fire Marshal may specify the hours of blasting. The contractor shall take all necessary precautions to protect life and property, including the use of an approved blasting mat where there exists the danger of throwing rock or over-burden. The contractor shall keep explosive materials that are on the job site in special constructed boxes provided with locks. 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. Where blasting takes place within five-hundred feet of a utility, structure or property which could be damaged by vibration, concussion or falling rock, the contractor shall be required to take seismograph readings and to keep a blasting log containing the following information for each and every shot:

1) Date of shot
2) Time of shot
3) Crew Supervisor
4) Number and depth of holes

5) Approximate depth of overburden
6) Amount and type of explosive used in each hole
7) Type of caps used (instant or delay)
8) The weather
9) Seismograph instrument and readings

c) This blasting log shall be made available to the Water Resources Director upon request and shall be kept in an orderly manner. It shall be the contractor's responsibility to have adequate insurance to cover any damages resulting from blasting so to hold the Town of Apex harmless from any claims.

SECTION 600
WATER DISTRIBUTION SYSTEM

601 Water Distribution Pipe

A. Design

The following Standard Specifications and associated Standard Detail Drawings shall apply to all water system extensions and development of the Apex municipal water system. The Standard Specifications included herein shall apply to all aspects of the Apex water system that is owned, operated and maintained by the Town of Apex.

All utility extension permits must be obtained prior to construction. Refer to General Provisions in Section 0200 for further requirements.

1. Location: Water transmission lines shall be located and sized in accordance with the current "Water System Master Plan" or as directed by the Town, and shall extend to the adjacent properties to provide an adequate network. All public water mains shall be located within dedicated right of way of Town roads, outside of the right of way on NCDOT roads, or dedicated easements with a minimum width of 20 feet. Dedicated easements for water mains and appurtenances shall be recorded as "Town of Apex Public Waterline Easement." Town of Apex utility and pipeline easements shall contain only Town of Apex utilities unless otherwise approved by an approved site plan or encroachment agreement. Easements that are shared by water mains and greenway paths shall have a minimum width of 30 feet. Easements shall be acquired by the Developer (unless utility is designed as part of a Capital Improvement Project) prior to construction approval.

   If the water main is located within the road right-of-way, a clear width equal to or greater than the easement width required must be available. If adequate width is not available within the right-of-way, additional easement outside of the right-of-way must be maintained. For example, if a water main normally requiring a 20 foot easement is installed 5 feet inside of the right-of-way, an additional 5 feet of easement must be obtained outside of the right-of-way to provide a clear total width of 10 feet on each side of the pipe.

   All water main extensions and distribution facilities which connect to the water distribution system of the Town shall be considered as public facilities up to the metering point. Therefore, all such facilities must be installed in public street right-of-way (not alleys) or centered within an easement. Extensions shall terminate at the furthermost property line fronting the property.

   Where deemed necessary to enhance water flow and/or pressures in the area, extensions may be required to be “looped” to an existing water main or “dead end” line within the area being developed.

If a proposed development site has a gap in road frontage, the development shall extend the water main along the road frontage to eliminate the gap in water service, unless otherwise approved by the Water Resources Director.

Mains shall not be installed under any part of water impoundments or area to be impounded. Mains shall not be installed through, above, or below any retained earth structure. Main location and depth shall not be within the theoretical 1:1 slope of any impoundment dam or structure, or shall maintain a minimum of 10' horizontal separation from the toe of slope, whichever is greater. The entire easement shall be outside of the toe of slope, unless prior approval is obtained from the Water Resources Director.

Easement Areas: No permanent structures, equipment, retaining walls, embankments, impoundments, or other elements that would inhibit maintenance operations shall be constructed within a utility and pipeline easement. Fences may be allowed across easements provided that appropriate access gates or removable panels have been installed to allow utility maintenance. Fences shall not be installed parallel within utility easements. Fill or cut slopes greater than 4:1 are not allowed to extend into easements. Easements must be clearly labeled as public or private.

Where public water mains are installed within easements crossing private property, the Water Resources Department shall have the right to enter upon the easement for purposes of inspecting, repairing or replacing the water mains and appurtenances. Where paved private streets, driveways, parking lots, etc. have been installed over the public water mains, the Town of Apex shall not be responsible for the repair or replacement of pavement, curbing, etc. which must be removed to facilitate repairs. The Water Resources Department shall excavate as necessary to make the repair, and shall backfill the disturbed area to approximately the original grade. Replacement of privately owned pavement, curbing, walkways and any other private infrastructure shall be the responsibility of the property owner or Homeowner's Association.

Easements shall be accessible from public rights-of-ways. If easement is not accessible perpendicular from right-of-way due to steep slope, environmental feature, or other obstacle, additional easement may be necessary.

Only one utility can be installed per easement, unless prior approval from the Water Resources Director is obtained.

2. Sizing: Major transmission lines shall be sized in accordance with the "Water System Master Plan" or as directed by the Town. Six (6) inch

mains may be used on a case by case basis when the Town has determined that a sufficient grid exists and the existing network supports using six (6) inch mains. The total maximum length of 6 inch and 8 inch lines, without connecting to a larger main, is 1200 feet and 2000 feet, respectively. Where the existing network is lacking connectivity, lines shall be upsized to provide adequate fire flow as directed by the Director of Water Resources. All lines shall be designed to maintain a minimum of 20 psi at maximum daily demand with applicable fire flow conditions. Water distribution facilities for Multi-Family Units, Apartments, Condominiums, and Townhouse Developments shall comply with the provisions for Business, Commercial, and Industrial Zoning Districts indicated below.

Business, Commercial, and Industrial Zoning Districts - Water mains shall be 8- inch and 12- inch minimum. Eight-inch shall be used only when it completes a good grid and the maximum length of 8-inch lines without connection to a larger feeder main is 1,200 feet unless special approval for deviation from this requirement is granted by the Director of Water Resources.

Where water mains dead end or are terminated for future extension, at least one full length stick of ductile iron pipe shall be installed with a thrust collar, main line valve, and blow-off assembly. This dead end shall terminate within a right-of-way or dedicated easement.

Dead end mains may be extended to existing mains in adjacent streets when it is practical to do so in order to enhance flow, water quality, and/or pressure in the affected area.

3. Restraint:

All valves and fittings shall be restrained. Pipe joints shall also be restrained an adequate length away from valves and fittings in accordance with AWWA manual M41 (or the latest edition of *Thrust Restraint Design for Ductile Iron Pipe* as published by the Ductile Iron Pipe Research Association). The standard joint restraint method shall be to use manufacturer provided restrained joint pipe and fittings.

a) 6” to 12” Diameter Pipe: For pipe 6-inches through 12-inches, the following table may be used to determine the required restrained length of pipe for single occurrences of valves or fittings within the pipe system. The table may not be used for combined bends or offsets where a series of fittings occur. In lieu of using the below table, a pipe restraint plan detailing all assumptions and calculations may be provided by the NC Professional Engineer sealing the plan drawings. In either case, the method of restraint to be used and the

length of pipe to be restrained (if applicable) shall be clearly identified on the plans at all necessary locations.

Required Restrained Lengths for Single Fittings and Valves for Pipe 6-inches to 12-inches in Diameter (in Feet, Both Directions unless otherwise noted)

	6”	**8”**	**10”**	**12”**
45° Horizontal **45° Vertical Up** **45° Vertical Down**	34’ 34’ 53’	44’ 44’ 69’	53’ 53’ 82’	61’ 61’ 96’
22½° Horizontal **22½° Vertical Up** **22½° Vertical Down**	17’ 17’ 26’	21’ 21’ 33’	26’ 26’ 40’	30’ 30’ 47’
11¼° Horizontal **11¼° Vertical Up** **11¼° Vertical Down**	8’ 8’ 13’	11’ 11’ 17’	13’ 13’ 20’	15’ 15’ 23’
Tee ***(Restrain the Branch)***	*6”* – 115’	*6”* – 111’ *8”* – 154’	*6”* – 107’ *8”* – 151’ *10”* – 186’	*6”* – 103’ *8”* – 148’ *10”* – 184’ *12”* – 220’
Reducer ***(Restrain Larger Pipe)***	N/A	70’	10” x 8” – 67’ 10” x 6” – 122’	12” x 10” – 68’ 12” x 8” – 123’ 12” x 6” – 169’
Dead Ends (*Caps and Plugs*) & Inline Valves	126’	165’	198’	232’

b) All valves, pipe, and fittings: **Projects with pipe diameters greater than 12-inches, poly-wrapped pipe, or combined bends must have a pipe restraint plan with the method of restraint to be used and the length of pipe to be restrained clearly identified on the plans at all necessary locations.** The pipe restraint plan must be calculated in accordance with AWWA manual M41 (or the latest edition of *Thrust Restraint Design for Ductile Iron Pipe* as published by the Ductile Iron Pipe Research Association). The plan must also account for the actual soil types that exist at the project site. A minimum safety factor of 1.5 (2.0 if/when required by NCDOT) and a minimum pressure of 200 PSI must be used.

c) Valves: Valves shall be restrained in a manner consistent with operation as a dead end. This includes restraining the valve to the pipe and restraining a sufficient number of pipe joints on both sides of the valve to accommodate dead end restraint. Valves located at waterline intersections (at tees and crosses) shall have no joints between the valve and fitting.

d) Dead Ends: All MJ cap and plug fittings, including tapped caps, shall be restrained with approved wedge action retainer glands. The

adjacent pipe shall be restrained the distances specified above (or on the sealed pipe restraint plan). Reaction blocking shall not be used to restrain caps and plugs.

e) All pipe restraint systems shall be factory produced by the manufacturer. Approved wedge action retainer glands or bell restraints may be used for pipe/fittings up to (but not including) 16" in diameter. Restraint on mains 16" and larger shall be factory produced by the manufacturer.

f) Restraining systems not included within this Specification shall require written approval prior to utilization. All joint restraint products that include the means of restraint within the joint gasket shall be prohibited in the Town of Apex water system.

4. Depth of Installation:

All water mains shall have a minimum cover of 3 feet measured from the top of the pipe to the finished grade. Water mains shall have a maximum cover of 8 feet measured from the top of the pipe to the finished grade. Installations requiring greater than 8 feet of cover due to road crossings, stream/wetland crossings, or other conflicts must have prior approval from the Water Resources Director.

When water lines are installed along a roadway they shall be installed at sufficient depth to maintain three (3) feet of cover to the subgrade of any future road improvements including potential vertical alignment changes.

5. Relation to Sanitary and Storm Sewers:

Separation between Potable Water Mains and Sanitary Sewer Mains or Storm Sewers.

a) Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 5-ft lateral separation and water line at least 18-inches above sanitary sewer line measured vertically from top of sewer pipeline to bottom edge of water main.

b) Crossings (Water Main Over Sanitary or Storm Sewer): All water main crossings of sanitary sewer lines shall be constructed over the sewer line in conformance with Town of Apex Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sanitary sewer main, 24-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the storm sewer main. If 18-inches or 24-inches, respectively, of clearance is not

achievable, the water main and sanitary/storm sewer main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards. The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole. When the separation between pipelines is 18-inches or less, the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for both sanitary and/or storm sewer crossings of potable water mains.

c) Crossings (Water Main Under Sanitary or Storm Sewer Line): Allowed only as approved by Town of Apex, when it is not possible to cross the water main above the sanitary or storm sewer line. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and both the water main and sanitary/storm sewer shall be constructed of ductile iron in conformance with water main construction standards. The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

B. Materials

General: All water main distribution pipe shall be ductile iron. The following table lists approved manufacturers of DIP, DIP fittings, and RJDIP that are allowable for installation within the Town's system.

Product Category	Approved Manufacturer	Model/Series	Pressure/Load Rating	Reference Standard	Requirements
Ductile Iron Pipe	US Pipe	Tyton Joint	250-350 psi	AWWA C150 and C151	Cement mortar lined with exterior bituminous coating. McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Fittings	Sigma	Mech. Joint	250-350 psi	AWWA C110/C111 and AWWA C153	Shall always meet or exceed pipe pressure rating
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			
Ductile Iron Restrained Joint Pipe	US Pipe	TR Flex	250-350 psi	AWWA C150 and C151	Boltless restraint unless otherwise specified
	American (ACIPCO)	Flex Ring			
	McWane	TR Flex (pipes 24" and smaller)			

1. Ductile Iron Pipe

   a) Ductile iron pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum required pressure ratings for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DI Water Mains

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
6-8 -inch	type 1	350 psi	3-16 feet
6-8 -inch	type 4	350 psi	16-20 feet
10-12 -inch	type 1	350 psi	3-10 feet
10-12 -inch	type 4	350 psi	10-20 feet
14-20 -inch	type 4	250 psi	3-20 feet
24-30 -inch	type 4	250 psi	3-20 feet
36-42 -inch	type 4	300 psi	3-20 feet

*Any installation deeper than 20 feet must obtain approval from the Water Resources Director and no practical alternative must be proven.

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

b) Pipe joints shall be mechanical joint or push-on type as per AWWA C111. Pipe lining shall be cement mortar with a seal coat of bituminous material in accordance with AWWA C104. All buried ductile iron pipe shall have a bituminous exterior coating in accordance with AWWA C151.
c) Pipe manufacturer must have a supplier within 200 miles of the Town of Apex.

2. Ductile Iron Fittings

All ductile iron fittings shall be provided in conformance with AWWA C110 for standard ductile iron fittings and AWWA C153 for compact ductile iron fittings. All fittings shall be pressure rated for a minimum 350-psi through 24-inches in diameter and 250-psi for fittings greater than 24-inches in diameter. In cases where minimum pressure standards are less than the pipe specification, fittings shall always be pressured rated to meet or exceed the pressure ratings for the specified pipe. All fittings for potable water service shall be provided with cement mortar linings and asphaltic seal coats in accordance with AWWA C104. All ductile iron fittings shall have an asphaltic exterior coating in accordance with AWWA C151. All ductile iron fittings shall be provided with mechanical joint end connections or proprietary restrained joints from an approved manufacturer. Gaskets shall be provided in conformance with AWWA C111 with EPDM rubber gaskets preferred over SBR. Two 45 degree fittings shall be used in lieu of 90 degree fittings in all horizontal and vertical installations, with exception of reverse taps.

Fitting manufacturer must have a supplier within 200 miles of the Town of Apex.

3. Restrained Joint Ductile Iron Pipe
   All restrained joint ductile iron pipe unless otherwise specified shall be of the boltless restrained joint type. For installations requiring welded locking rings, the rings shall be factory welded.

   All proprietary pipe restraint systems shall be approved by the Town of Apex and provided in compliance with all standards for coatings, linings, pressure classes, etc. as required for ductile iron pipe. All restrained joint pipe shall be installed based on laying conditions, pressure class, etc. as required for typical ductile iron pipe.

   Restraining systems not included within this Specification shall require written approval prior to utilization. All joint restraint products that include the means of restraint within the joint gasket shall be prohibited in the Town of Apex water system

   Pipe manufacturer must have a supplier within 200 miles of the Town of Apex.

C. Installation

1. Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.

2. Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be plugged or capped when pipe laying is not in progress.

3. All pipe shall be constructed with at least 36 inches of cover below the finished surface grade or road subgrade. Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected. All transition joints between different types of pipe shall be made with transition couplings approved on shop drawings showing the complete assembly to scale.

4. Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and

solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

5. All valves that are under the ownership and acceptance of the Town of Apex municipal water system shall be operated only by trained personnel of the Town of Apex. Existing valves in the Town of Apex water system will not be operated without a minimum notice of 24 hours. Contractor's personnel shall only be responsible for operating valves within new construction areas that are not directly connected with the existing municipal water supply. At such time when the valves in new construction areas are connected with the municipal water supply, the valves shall only be operated by Town of Apex personnel or in limited circumstances by Contractor's personnel after receiving authorization from the Operator in Responsible Charge of the water distribution system.

6. The unloading and loading of pipe, fittings, valves, and related accessories shall be performed with care so as to avoid any damage to these materials. All such materials shall not be stored directly on the ground, but shall be on pallets, or other suitable supports, so as to prevent the entry of mud and debris into the pipe or other materials. Contractor shall also endeavor to store these materials in accordance with any special practices as required by the manufacturer.

7. Fittings shall be installed at the location indicated on the drawings with care taken to insure that joints are fully homed and fully and property supported.

8. Water mains shall not be installed within roundabouts or alleys.

602 Fire Protection

A. Fire Hydrants

1. Sizing of Mains

    a) Water mains shall be sized in order to meet minimum fire flow conditions according to the type and classification of the proposed development. Mains shall be sized in accordance with conditions set forth within the Town's Water Distribution Extension permit application.

2. Location

    a) All fire hydrants shall be installed on a minimum 6 inch water line. Only one fire hydrant may be installed when the line is served by a 6 inch tap and is not looped to another main. There shall be at least one fire hydrant at each street

intersection. Hydrants at intersections shall be located in accordance with the Standard Details. Valves provided on the fire hydrant branch supply line shall be located within 5-ft of the main line. The maximum length of a fire hydrant leg shall not exceed 50 feet.

b) In residential districts the maximum distance between hydrants, measured along street centerlines, shall be 500 feet. When residential intersections are less than 700 feet apart, a hydrant is not required between the intersections. For single-family residential projects, a hydrant shall be located at the end of all cul-de-sacs.

c) In business, office and institutional, and industrial zoning the maximum distance between hydrants, measured along street centerline, shall be 300 feet. If a building is completely equipped with a fire sprinkler system and the project is developed with a private water distribution system, all parts of the building shall be within 300 feet of a hydrant. Hydrants positioned greater than 50 feet from the public water main shall occur on a looped water main.

d) All premises where buildings or portions of the building are located more than 300 feet (commercial) or 500 feet (residential) from a fire hydrant, shall be provided with approved on-site fire hydrants and water mains capable of supplying the fire flow required by the Fire Department.

e) Residential developments which do not meet minimum fire flow requirements shall have individual fire protection systems designed and installed at each residence. Residential fire systems must be current Town Backflow Prevention Protection, listed under Section 620.

f) On thoroughfares and collector streets with access points only at street intersections, hydrants shall be located at each street intersection and at 1000 foot intervals along the street. Where these intersections are less than 1200 feet apart, no hydrant is required between the intersections. Fire hydrants shall be placed in a staggered arrangement on both sides of any roadway classified as a major or minor thoroughfare with the hydrant spacing as referenced above.

g) Where sprinkler systems are used, a fire department connection shall be within 50 feet of an accessible fire hydrant, unless otherwise permitted by the Fire Department.

h) Any proposed, relocated, or replaced water main that includes new fire hydrants shall require submittal of fire flow calculations.

i) Fire hydrant legs shall not be tapped from water service connections, they shall be tapped directly from the main line.

3. Specifications

Hydrants shall conform to AWWA C502 with a minimum valve opening of 4 1/2 inches. Hydrants shall be furnished with a 5 inch Storz steamer and double 2 1/2 inch hose connections with caps and chains, National Standard Threads, mechanical joint, 1 1/2 inch pentagon operating nut, open left, painted fire hydrant red, bronze to bronze seating, a minimum 4 foot bury depth with a break away ground line flange and break away rod coupling. The hydrant bonnet will be designed with a sealed oil or grease reservoir with O-ring seals and a Teflon thrust bearing. Fire hydrant caps shall be attached to the body of the hydrant with a minimum 2/0 twist link, heavy duty, non-kinking, machine chain. All fire hydrants shall be designed and rated for a working pressure of 250-psi or greater.

4. Installation

Hydrants shall be set plumb, properly located with the pumper nozzle facing the closest curb of a fire lane or street, but not a parking space. The back of the hydrant opposite the pipe connection shall be firmly blocked against the vertical face of the trench with 1/3 cubic yard of concrete. Double bridle rods and collars shall be connected from the tee to the hydrant. All joints between the tee and the hydrant shall be mechanical joints restrained with wedge action retainer glands. Stainless steel rods not less than 3/4 inch diameter may also be used to restrain the assembly. A minimum of 8 cubic feet of stone shall be placed around the drains. The backfill around the hydrants shall be thoroughly compacted and closely match the elevation on the approved plans. Hydrant extensions will not be allowed on new or retrofit installations. Hydrant installation shall be in accordance with the Details. Hydrant tees may be used upon approval of the Water Resources Department. A clear level space of not less than 10 feet shall be provided and maintained on all sides of a fire hydrant for immediate access. Clearance from the ground surface to the steamer nozzle shall be between eighteen (18) inches and twenty-four (24) inches.

5. Depth of Bury:

Typical 90-Degree Hydrant Shoe Installations:
The maximum depth of bury for all new fire hydrants with 90-degree hydrant shoes shall be 5-ft from the breakaway flange connection. The breakaway flange or safety coupling shall be oriented vertically just above finished grading and bolted directly to the fire hydrant in compliance with manufacturer standards. The breakaway flange or safety coupling shall not be buried.

Vertical Shoe Hydrant Installations:
For installations requiring depth of bury greater than 5-ft, the fire hydrant shall be equipped with a vertical shoe arrangement that provides for full extension of the lower valve plate against a stopping mechanism located inside the vertical shoe to maximize hydraulic flow conditions through the hydrant. The vertical shoe shall

be equipped with flanged connections. The maximum depth of bury for vertical shoe installations shall not exceed 4-ft measured from the breakaway flange to the bottom of the vertical hydrant shoe. The vertical shoe and all piping included in the hydrant supply line shall be restrained with blocking and rodding or blocking with wedge action retainer glands or standard Aquagrip, Grip Ring, or Romac connections.

6. Hydrant Relocations: For installations where hydrants will be relocated, all hydrants with greater than 20-years of operational service, as indicated by the date of manufacture provided on the hydrant, shall be replaced with new fire hydrants. The existing fire hydrant shall be turned over to the Town of Apex Public Works Department.

   For installations where the hydrant to be relocated has less than 20-years of operational service, the existing hydrant may be relocated. The existing hydrant shall still be disinfected, flushed and pressure tested.

   All fire hydrants shall be initially tagged and/or bagged “NOT IN SERVICE”. This tag or bag shall not be removed until approved by the Inspector.

B. Automatic Fire Sprinkler Systems

1. General: Four (4) complete sets of working plans and calculations for all fire sprinkler systems and standpipe systems shall be submitted as required by the Inspections and Permits Department for review and approval. If 20 sprinkler heads or more are modified or added to an existing sprinkler system, if any modifications occur in the hydraulically calculated remote area, or the hazard classification changes, a plan submittal including complete calculations and a permit will be required. All fire sprinkler systems shall be installed with an alarm check valve installed in each riser with all required appurtenances (example: retard chamber, water motor gong, pressure gauges, etc.). Exception: NFPA 13 D and 13 R residential sprinklers when approved by a fire official. All installations, minor repairs, or minor replacements shall be performed by a licensed fire sprinkler contractor. Contact the Inspections and Permits Department for a permit application.

2. Design: Approved working plans shall be in complete compliance with NFPA No. 13, 13D, 13R, 14, 231, 231C, 231D, 231F and Town Specifications. An NFPA above ground material and test certificate and NFPA underground material and test certificate are required after completion of designated, approved work.

3. Hydraulic Design: If a system is hydraulically designed, the following design criteria must be followed:

a) Safety Margin: In all cases, a fixed minimum safety margin of at least 10-psi shall be applied to the design calculations. (Example: Demand = 70 psi, Supply $\geq$ 80 psi)

b) Hose Allowances: Both exterior and interior hose allowances shall comply with NFPA 13 requirements.

c) Water Supply Pressure: The sprinkler system designer shall be responsible for verifying system pressure. Refer to Town of Apex Policy Statement 129 regarding Minimum Water Supply Pressure.

4. Backflow Prevention: When a fire protection system is proposed, with a Fire Dept. connection or as otherwise required by the Cross Connection Ordinance a reduced pressure principle detector assembly (RPDA), two and one half inch or greater, shall be installed on the supply side of the sprinkler fire protection line inside the riser room. A two inch or less reduced pressure principle assembly may be allowed if the site is designed for that size. At no time shall any fire backflow preventer outlet be smaller than the water pipe inlet. These backflow prevention devices must be UL listed and/or listed by Factory Mutual Research Corporation. Reduced pressure principle detector assemblies shall not be arranged vertically. For all RPDA's, a relief valve drip cup piped outside the building shall be provided. The relief valve drain may be piped to the main building drain but must meet current specification listed in Section 620 or the drain be sized per the manufacturer recommendations, whichever is more stringent.

5. Post Indicator Valve (PIV): A post indicator valve may be provided at the right of way or edge of easement at least 40 feet from the building if space permits. Each connection into the building shall have a post indicator valve. The top of the PIV shall be 30-42 inches above finished grade and 36-inches of unobstructed access perimeter shall be maintained around the PIV.

   In urban settings, a wall mounted indicator valve may be used where there is no suitable location for a post mounted indicator valve. Wall mounted indicator valves shall be centered 30–42 inches above the finished grade. It shall be greater than 10-ft from any door, window, or other protected opening along the wall.

   All indicator valves regardless of type shall have an electronically controlled tamper switch. All PIVs shall be made of ductile iron construction and shall be UL listed and FM approved. The stand pipe of all PIV's shall be painted red.

6. Fire Department Connection: Where automatic fire sprinkler systems or standpipe systems are used, a fire department connection with National Standard threads shall be provided within 50-ft of a fire hydrant, except for town homes, apartment buildings, and within urban settings where greater lengths may be permitted. When a sprinkler system serves only part of a large structure, the fire department

connection shall be labeled, with minimum 2 inch letters on a permanent sign, as to which section of the structure that sprinkler riser serves.

7. Dedicated Riser Room: A dedicated sprinkler riser room is required providing an entry door to the room from the exterior of the building. All dedicated riser rooms shall be equipped with a floor drain sized appropriately to prevent flooding. The floor drain shall be piped to storm system or main building drain. The floor drain shall be provided with a circular raised ring/hub around the floor drain to prevent debris and/or chemicals from entering the drain during an emergency spill. The hub shall be fabricated of cast iron or other corrosion resistant material and extend at least 3-inches above floor elevation. All BFPs located inside of a building must have direct access to that room from the building exterior.

8. Alarm Communication: All sprinkler systems are to have alarm communication equipment to fully comply with NFPA 72. Equipment must be fully functional and reporting to a UL listed central receiving station before a Certificate of Occupancy is issued for the facility.

9. Access: All buildings which have an elevator, a fire alarm system monitored by a central receiving station, or a fire sprinkler protection system shall provide a “Knox Box” key entry system. This “Knox Box” shall be mounted on the exterior entrance to the dedicated riser room or at the normal fire department entrance when no fire sprinkler system is provided and there is no dedicated riser room. Mount “Knox Box” on wall at 5 feet A.F.F. on door handle side of dedicated riser room door or entrance door. This “Knox Box” shall be ordered through the Town Fire Department and shall be in place before a Certificate of Occupancy is issued. Keys to access the facility shall be provided to the Fire Department by the owner/manager. An access door directly to the mechanical room or mechanical storage area shall be provided.

10. Identification: The exterior door leading to the dedicated sprinkler riser room shall be labeled with minimum 2 inch lettering designating “SPRINKLER RISER ROOM” in a contrasting color. Durable vinyl lettering is suggested.

11. Fire Alarm Panel Location: When a building is protected by an automatic sprinkler system and has a fire alarm system, the fire alarm control panel or a remote annunciation of the fire alarm control panel shall be placed in the sprinkler riser room. This control panel shall have the capacity of silencing and resetting. Adjacent to the fire alarm control panel shall be a framed zone map. Nomenclature shall correspond with the zone map. Submit four complete sets of plans and specifications to the Inspections and Permits Department for approval prior to installation of equipment or wiring. When there is no sprinkler system in a building, the fire alarm control panel or remote annunciator shall be located at the normal fire department entrance.

C. Fire Protection During Construction

The fire protection water supply system, including fire hydrants, shall be installed and be in at least functional status prior to placing combustible materials on the project site. If phased construction is planned, coordinated installation of the fire protection water system is permitted. Coordination of the water system will be done through the Water Resources Department.

603 Valves and Appurtenances

A. Valves

1. General

a) Valves shall be installed on all branches from feeder mains and hydrants according to the following schedule: 4 valves at crosses; 3 valves at tees; one valve on each hydrant branch and elsewhere as directed by the Director of Water Resources. When a loop section of water line is connected back into the feeder main within a distance of 200 feet or less, only one valve will be required in the feeder main. In all cases where new water mains are connected to an existing water distribution line, valves shall be located at all end points and at intermediate points throughout the new system extension to assure testing requirements can be met without interfering with the operation of the existing system.

b) Where no water line intersections are existing, a main line valve shall be installed at every 100 feet per 1 inch diameter main up to a maximum distance of 2000 feet between valves.

c) Valves shall be properly located, operable and at the correct elevation. The maximum depth of the valve nut shall be 5 feet without an extension kit. When valve extension kits are used, they must be manufactured by the same company which manufactured the valve.

d) Valves shall be set at locations shown on the plans with care being taken to support the valve properly and to accurately position the valve box over the operating nut of the valve. When valves are located in street right-of-way, but out of pavement, the boxes shall be adjusted to finish grade and a concrete collar 2-feet square and 6-inches thick shall be poured around the box ½-inch from the top of the casting, in lieu of the poured in place concrete a pre-cast concrete collar may be used such as manufactured by Brooks, Inc. or Buckhorn Products. Valve boxes located in the pavement shall be set flush with the current pavement. If the pavement requires a future final lift, the valve boxes shall be adjusted no more than 60 days prior to completion of the final lift. Stem extensions are allowed so that nut is within 30” of final grade.

When valves are located outside of street right-of-way, the boxes shall be

adjusted 6 inches above the finished grade, and a concrete collar 2-feet square and 6-inches thick shall be poured around the casting or approved concrete donut with marker. ARV's must be located at high points with positive slope on the line to the ARV in both directions.

2. Combination Air Valves

a) Combination air valves shall be provided to purge air from the system at startup, vent small pockets of air while the system is being pressurized and running, and prevent critical vacuum conditions during draining. Combination air valves rated for potable water use shall be installed at all high points of water lines 8 inches in diameter or larger and at other locations such as major changes in grade as directed by the Town. A high point shall be determined as any high location where the difference between the high elevation and adjacent low elevation exceeds 10-ft, unless otherwise determined by the Director of Water Resources based on special circumstances.

All combination air valves shall be provided in conformance with AWWA C-512. The water main shall be installed at a grade which will allow the air to migrate to a high point where the air can be released through an air valve. A minimum pipe slope of 1 foot in 500 feet should be maintained.

b) The combination air valve shall be sized by the Engineer, and approved by the Town. Combination air valves shall be of the single housing style with Type 304 or 316 stainless steel body that combines the operation of both an air/vacuum and air release valve. The valve shall be rated for minimum 230 PSI working pressure. The combination air valve shall be provided with cylindrical shaped floats and anti-shock orifice made of high density polyethylene. Combination air valves with spherical floats shall not be accepted. All combination air valves shall be installed in accordance with the Details.

c) 2 inch combination air valves shall be installed in a standard 4-foot diameter eccentric manhole. The 2 inch valve shall have a 2 inch male NPT inlet. Connection to the main shall be with a saddle tap in the same sizing as the combination air valve assembly and isolated with a gate valve also of the same size. The isolation gate valve shall be provided with NPT threads and connected with "no lead" brass (meeting UNS C89833 as per ASTM B584) or bronze piping. Brass or bronze ball valves may be used in lieu of gate valves for 2-inch installations. The isolation valve shall be rated for 200-psi service or greater.

d) Combination air valves 3-inches and greater shall be installed in a flat top manhole sized according to the water main diameter. Mains less than or equal to 20" shall utilize a 5 foot diameter manhole and larger mains shall utilize a minimum 6 foot diameter manhole. All connections shall be by flange joints.

Connection to the main shall be by an MJ x FLG tee with the branch diameter equal to at least half of the main diameter. If needed due to larger diameters, a flanged reducer shall be provided prior to the flanged gate valve sized equally to the flanged combination air valve.

Precast concrete manholes shall meet the requirements of the Standard Details.

3. Gate Valves, Less than 4-inches for Blowoff Assemblies

Gate valves for blowoff installations sized smaller than 4-inches, shall be resilient seated wedge type with a non-rising stem and a 2 inch operating nut in compliance with AWWA C509. The smaller diameter gate valves shall be provided with triple O-ring seals and threaded end connections in compliance with ANSI B2.1. Gate valves smaller than 2-inches shall be identified “no lead” and consist of brass components designated under UNS C89833 as per ASTM B584. The small diameter gate valves shall be rated for a minimum pressure rating of 200-psi.

4. Gate Valves, 6-inches to 12-inches

All valves for potable water applications, 6-inches in diameter to 12-inches in diameter shall be resilient seated wedge gate valves in conformance with the requirements of AWWA C509, (grey or ductile iron body) or AWWA C515, (reduced wall ductile iron body). All coating materials used in the construction of gate valves for potable water applications must comply with NSF 61 to assure lead free construction. All gate valves shall be designed for a working pressure of 250-psi with a minimum UL listing and FM approval rating of 200-psi. Gate valves shall be fusion bonded epoxy (FBE) coated both interior and exterior at a minimum of 10-mils and the FBE coating shall be provided in conformance with AWWA C550. All gate valves shall be assembled with stainless steel bolts.

All gate valves 6-inches in diameter to 12-inches in diameter shall be installed in the vertical position and shall be provided with mechanical joint fittings. Gate valves shall be restrained by wedge action retainer glands or other approved manufacturer provided restraining systems. All gate valves shall open left with a non-rising stem (NRS) and be provided with a 2-inch square operating nut. All gate valves shall be constructed with triple o-ring seals in which 2 o-rings are located above the thrust collar and 1 o-ring is located below the thrust collar. The two upper o-rings shall be replaceable with the valve fully open and subjected to full rated working pressure.

The gate valve wedge shall be fully encapsulated in rubber. All valves shall be rated for bi-directional flow. All sealing gaskets shall be made of EPDM rubber materials.

Valves shall be Mueller or approved equal.

5. Gate Valves, 14-inches through 48-inches

   Gate valves 14-inches through 48-inches shall be resilient seated wedge gate valves in conformance with the requirements of AWWA C515, (reduced wall ductile iron body) and shall comply with all Specifications outlined for gate valves 6 through 12 inches. Gate valves installed vertically shall be provided with a minimum of 2-ft of overhead clearance between the top of the operator nut and the finished grade. All gate valves 18-inches and greater shall be provided with a geared actuator. Vertical gate valve installations shall have spur gear actuators and horizontal installations shall have bevel gears.

   Gate valves 18 inches in diameter shall be provided with a gear operator at a minimum 2:1 ratio and larger valves through 24-inches shall be provided with a gear operator at a minimum 3:1 ratio.

   Gate valves installed in a horizontal position shall only be provided as permitted by the Director of Water Resources for special circumstances where vertical alignment is not possible. All horizontal gate valves shall meet or exceed the Specifications outlined herein for vertical gate valves including the 250-psi pressure rating. All horizontal gate valves shall be equipped with bevel gears resulting in a minimum 4:1 turn ratio for valves 30 through 48-inches in diameter.

   Valves shall be Mueller or approved equal.

6. Butterfly Valves: Butterfly Valves shall not be used in the Town of Apex water system unless permitted by the Director of Water Resources in unique cases where a gate valve cannot be installed. All butterfly valves shall meet the requirements of AWWA C504 with mechanical joints, 2 inch open left operating nut. Valves greater than 12-inches shall be installed in a manhole with the 2-inch nut accessible from above grade. Valves designated by the Town to potentially have a remote actuator shall also be installed in a manhole regardless of size. All butterfly valves shall be rated for a working pressure of 200-psi or greater. Butterfly valves shall be provided with a fusion bonded epoxy coating on both interior and exterior surfaces at a minimum of 10-mils with an NSF 61 approved epoxy. All rubber seals and gaskets shall be made of EPDM rubber.

7. Insertion Valves: Insertion valves shall only be used as permitted by the Water Resources Department. Insertion valves shall meet the requirements of AWWA C515, seat on the valve body and be rated for a working pressure of 250-psi or greater. All insertion valves shall be made of ductile iron in conformance with ASTM A-536 Grade 65-45-12 and epoxy coated at a minimum of 10-mils. Insertion valves are available for pipe sizes through 12-inches in diameter. In cases where insertion valves are being installed to shut down water to a work zone area, the insertion valve shall be located a minimum of 100-ft from the work zone or greater as determined by the Engineer of Record to assure the insertion valve can safely

operate as a dead end without dislodging from the pipeline or otherwise causing the existing pipeline to shift.

8. Valve boxes

   a) Valve Boxes shall be cast iron, screw type, with a 5 inch opening and "water" stamped on the cover. The cover shall be 6-inches in depth. All valve box assemblies and covers shall be cast from Class 35 gray iron and domestically made and manufactured in the USA. Boxes shall be painted prior to shipment with a coat of protecting asphaltic paint.

   b) Valve box ring adjustments will not be allowed. The valve box shall be centered over the wrench nut and seated on compacted backfill without touching the valve assembly. All valve boxes in pavement shall be flush with the top of the pavement or flush with the finished grade. Outside of paved areas precast concrete valve box encasements or a trowel finished 2' x 2' x 6" pad of 3000-psi concrete may be used for valve box encasement provided the assembly is buried flush with the surface grade and compacted properly to prevent movement of the precast encasement.

9. Actuators: All valves shall be provided with standard 2-inch operating nuts. Unless otherwise specified, the direction of rotation to open the valves shall be to the left, (counterclockwise), when viewed from the top. Each valve body or actuator shall have cast thereon the word “OPEN” and an arrow indicating the direction to open.

B. Appurtenances

1. Blowoffs:

   a) Blowoffs shall be the same size as the water main installed on and installed at the end of all dead-end water lines.

   b) Blowoff Assemblies shall be constructed as shown in the Details. The valves shall be gate type with a non-rising stem and a 2 inch operating nut, O-ring seals and screwed ends. A full size gate valve is required on water mains that are planned to be extended.

2. Reaction Blocking: Material for reaction blocking shall be 3000 psi concrete, poured in place. The reaction areas are shown in the Details. A minimum 6 mil plastic shall cover the fitting to ensure that no concrete will interfere with removal of the fitting. Blocking shall be installed in addition to pipe restraint. Blocking shall be installed against solid, undisturbed earth.

3. Rodding: All rodding shall be constructed with type 304 stainless steel rods at the number and sizing specified in the following table. Rod coupling shall not be allowed. All hardware shall also be stainless steel type 304.

Stainless Steel Rod Requirements are as follows**:**

6-inch branch	2, ¾-inch stainless steel rods
8-inch branch	4, ¾-inch stainless steel rods
12-inch branch	6, ¾-inch stainless steel rods
16-inch branch	8, ¾-inch stainless steel rods

4. Wedge Action Retainer Glands:
   All wedge action retainer glands shall be manufactured as a one piece retainer gland for use with mechanical joints and shall be rated to provide restraint up to 350-psi pressure rating for sizes through 16-inches. For sizing above 16-inches, the wedge action retainer gland shall be rated to provide restraint up to 250-psi. Approved wedge action retainer glands shall be made of ductile iron, coated with a manufacturer applied epoxy coating or polyester powder coating.

   In cases where wedge action retainer glands are approved for pipe restraint of fire hydrant supply lines or other applications, the entire hydrant supply line shall be restrained.

   Wedge action retainer gland connections to push on pipe are not approved.

5. Sampling Stations:

   Sampling Stations shall be provided at all new residential and commercial development areas at the rate of 1 sampling station per development complex consisting of at least 200-homes or 1- per 10 acre or greater commercial complex or 1 per institutional facility with more than 100,000 square feet or as otherwise required by the Director of Water Resources. Padlocks for sampling stations shall be provided by the Town of Apex Public Works Dept. The sampling station requirement may be waived in cases where area sampling is already deemed sufficient by the Town.

   Sampling stations shall be provided as a self-contained manufactured assembly with locking aluminum housing, copper drainage tube and unthreaded spigot.

6. Gaskets for Contaminated Installations

   a) Installation within contaminated areas should be avoided. If not possible or practical, and with prior approval from the Water Resources Director, water mains may be installed within some areas of contamination.

   b) The common type of gasket used for DIP is made of a synthetic rubber, which is a copolymer of styrene and butadiene (SBR). It is generally suitable for applications in fresh water, salt water and sanitary sewage environments. All

gaskets for DIP shall meet the minimum requirements of AWWA C111/A21.11. Gaskets for all PVC sewer pipes shall meet the requirements of ASTM F477.

c) Nitrile (NBR) or Buna-N gasket is another type of gasket made of synthetic rubber, which is a copolymer of butadiene and acrylonitrile. In general, this type of synthetic rubber has good resistance to refined petroleum products like gasoline, kerosene, jet fuel and lubricating oils. It may not be effective for use with aromatic hydrocarbons like benzene and toluene or chlorinated hydrocarbons like chloromethane and chlorobenzene.

7. Polyethylene Wrapping

When soils and/or field conditions require polyethylene wrapping of water mains, wrap shall be provided and installed in accordance with ANSI/AWWA C105/A21.5. When installed with restrained joint pipe, calculations for length of restrain must factor in the use of wrapping.

8. Marker Posts

Water main shall be marked with a plastic marker at every valve, every horizontal fitting, and spaced every 1,000 feet along the water main. The post shall having a minimum diameter of four inches and a minimum bury of thirty inches with a minimum of four feet exposed. The exposed portion shall be painted blue and label “Apex Water”. Marker posts shall be installed through easements, all non-residential areas, and as directed by the Water Resources Director. Valves shall have marker posts only when they are installed outside of paved areas.

604 Water Main Taps and Services

A. Design

1. Individual water services shall be provided from the main to each water meter for single family residences in accordance with the Details. Gang meters are prohibited, with exception to installations at apartment buildings or multiple commercial units within a single building where metering individual dwelling units may be impractical. All connections shall be made by wet taps. Service connections shall be made perpendicular to the main and shall run straight to the meter. Any deviation from this standard must be approved by the Water Resources Director prior to implementing the change.

2. All water service lines shall be installed with a minimum depth of cover of 24-inches or greater.

3. All water meter boxes and vaults shall be located at the edge of the serviced lot’s right of way or easement. Water meter boxes shall not be placed in streets,

sidewalks, parking areas or obstructed by fencing or buildings. A 5-foot clear zone easement shall be maintained around meter boxes and vaults.

4. Provisions for backflow prevention shall be in accordance with existing Town standards and specifications as well as the NC Plumbing Code.

5. The water meter shall be sized based on water demand. All water service lines shall be minimum 3/4 inch diameter. Multiple branches up to a maximum of 2 potable water services per multiple branch assembly for a single residential use shall be sized by the Engineer of Record in accordance with AWWA M22, but shall not be less than 1.5-inches in diameter.

6. Service taps to new water lines shall be made by the Contractor/Developer in accordance with the Specifications after obtaining applicable permits and paying applicable fees.

7. No taps shall be made within 3-feet of the bell or spigot end of the pipe or within 20 feet of a dead end.

8. Water service supply lines shall be continuous from the water main to the meter, no connections or joints are allowed, for services up to and including 2-inch. No services shall be tapped on water transmission mains.

9. Multiple meters on branched services are acceptable for multi-family projects. Multiple meters and water services greater than ¾" in size used in gang meter installations shall require design calculations certified by a professional engineer licensed in North Carolina and submitted to the Town prior to construction approval.

   All multiple meter installations shall conform to the Standard Detail and shall contain a curb stop on the feeder line. The curb stop shall be buried and shall be equipped with a curb box.

10. Meter installation - The Town of Apex shall provide and install (¾" – 2") water meters subject to the following conditions:
    - The Town has received a copy of the waterline purity test results and the Engineer' certification.
    - The Developer (or property owner) has paid all acreage fees.
    - The Developer (or property owner) has paid prescribed meter fee.
    - The Developer has installed all specified improvements or guaranteed their installation as prescribed in the Town Code.

11. No services shall be made directly to water mains that are 12" or larger. These connections must utilize a cut-in tee and appropriate reducers/fittings.

12. Service connections larger than 2” shall be made by means of a tapping sleeve and valve or cut in tee.

13. All new water services shall be equipped with a dual check valve which shall be located immediately downstream of the meter.

14. All meters shall register in gallons.

15. Multiple meters may be installed in accordance with the Standard Detail.

16. Taps shall be made only on lines under pressure, and after mains have been tested and chlorinated. No taps on dry lines shall be allowed.

17. Taps shall be made in accordance with the Standard Detail and shall be a continuous run from the main line to the metering point without intermediate connections and/or joints.

18. Each service shall be flushed and disinfected after installation, abiding to the same requirements as water mains.

B. Materials

1. Full Body Tapping Sleeves: Mechanical Joint tapping sleeves shall be fabricated of ductile iron construction in a two-piece assembly with mechanical joint connections to the main line and flanged connection to the tapping valve. All MJ tapping sleeves shall be rated for a working pressure of 200-psi or greater and provided with a ¾-inch test plug for testing. All tapping sleeves shall be hydrostatically tested up to 200-psi before a tap is made. Tapping sleeves shall not be air tested.

   All mechanical joint tapping sleeves shall be manufacturer fabricated and approved for installation on the specific main line pipe material, whether ductile iron, plastic, cast iron or asbestos cement.

   Full body tapping sleeves must be used when the main line is greater than 24-inches. Tapping sleeves fabricated of carbon steel in a two-piece assembly with mechanical joint connections to the main line and flanged connection to the tapping valve will be considered for approval on a case by case basis for mains that are greater than 24-inches. Carbon steel sleeves should be rated for a working pressure of 250-psi or greater and be provided with a ¾-inch test plug. A fusion bonded epoxy coating shall be applied to all carbon steel sleeves.

2. Stainless Steel Tapping Sleeves, 6-inch through 12-inch main lines:
   Stainless steel tapping sleeves may be used in lieu of mechanical joint tapping sleeves for ductile iron or asbestos cement water mains through 12-inches in

diameter with branch sizing as shown in the following table. All stainless steel tapping sleeves shall be manufactured in conformance with AWWA C223. All stainless steel tapping sleeves shall have a stainless steel flange and be provided in a two piece assembly with a full circumferential gasket with tabbed gasket holding assembly and ¾-inch test plug. The back band shall be a minimum 14 gauge stainless steel and the front band (where the outlet is located) shall be a minimum 12 gauge stainless steel. The bolt bars shall be a minimum 7 gauge stainless steel. All stainless steel tapping sleeves shall be manufacturer rated for a working pressure of 200-psi or greater and hydrostatically tested to 200-psi before a tap is made. Stainless steel tapping sleeves shall not be air tested.

Stainless Steel Tapping Sleeve Sizes Allowed

Nominal Main Size (inches)	Nominal Branch Size (inches)
6	4
8	4
10	4
10	6
12	4
12	6
12	8

3. Stainless Steel Tapping Sleeves, 14-inch through 24-inch main lines:
   For larger diameter water mains, stainless steel tapping sleeves approved by the Town may be used in lieu of a mechanical joint tapping sleeve for cases where the branch line is 50% or less in diameter than the main line diameter. All of the previous Specifications described for tapping sleeves from 6 to 12 inches shall be met for stainless steel tapping sleeves for larger diameter water mains. Additionally, the outlet band for stainless steel tapping sleeves 14-inches through 24-inches shall be a minimum 7 gauge stainless steel. The back half of the sleeve shall be a minimum 12 gauge stainless steel.

4. Tapping Saddles, 14-inch through 24-inch main lines:
   Tapping Saddles may be used in lieu of mechanical joint tapping sleeves to tap mains 14 inches through 24-inches when the branch line is 50% or less in diameter than the main line diameter. Saddles shall be made of ductile iron providing a factor of safety of 2.5 with a working pressure of 250-psi. Saddles shall be equipped with an AWWA C110 flange connection on the branch. Sealing gaskets shall be O-ring type, high quality molded rubber having an approximate 70 durometer hardness, placed into a groove on the curved surface of the saddles. Straps shall be alloy steel. The minimum strap count for branch sizing from 4-12 inches is shown below.

Strap Requirements for Tapping Saddles

Nominal Saddle Outlet (inches)	Number of Straps
6	3
8	4
12	7

5. Corporation Stops:

   a) Corporation Stops shall be ball type, made of “no lead” brass (meeting UNS C89833 as per ASTM B584). Corp stops shall be complete with a compression coupling and AWWA Standard threads as per AWWA C800. Taps shall be located at 10:00 or 2:00 o'clock on the circumference of the pipe. Service taps shall be staggered alternating from one side of the water main to the other and at least 12 inches apart. The taps must be a minimum of 24 inches apart if they are on the same side of the pipe. All corporation stops shall be rated for a working pressure of 300-psi.

   b) No burned taps will be allowed and each corporation stop will be wrapped with Teflon tape for ductile iron pipe water mains. No taps are allowed on a fire hydrant line. No tapping shall be made where rodding is placed.

6. Service Saddles:
   Service Saddles shall be used for service taps larger than 1-inch on all ductile iron water mains 14-inches and greater, or when direct taps cannot be made. Service saddles shall also be used for all taps on existing water mains other than ductile iron, such as asbestos cement, PVC, etc. Service Saddles shall be provided with brass body and fasteners (85-5-5-5 waterworks brass or “no lead” brass meeting UNS C89833 as per ASTM B584) conforming to AWWA C800 and double straps made of silicon bronze conforming to ASTM A98 and factory installed grade 60 rubber gaskets. Service saddles shall be provided with AWWA standard threads per AWWA C800.

7. Copper Service Tubing: Copper service tubing shall be type K soft copper tubing per ASTM B88. No union shall be used in the installation of the service connection of 100-feet or less. Service lines more than 100 feet shall use a three (3) piece compression coupling. Only one (1) compression coupling shall be used for each 100 feet or fraction thereof.

8. Meter boxes for ¾ and 1 inch services: ¾ and 1-inch meter boxes shall behigh density polyethylene (black). Meter boxes shall provide a cover opening of at least 7.5 X 13 inches and boxes shall measure at least 18 inches in depth. Lids may be designed with an internal housing for the ERT device, or with mounting bracket.

They shall also be lockable. Lids shall be provided with a 2 inch (maximum) diameter hole to accommodate a transmitter. All meter boxes and lids shall be installed as shown in the Details and shall meet AASHTO HS20 load bearing capacity.

Meter boxes shall have 45 degree compression connections outside the box on the inlet side. There shall be a lockable ball valve inside the box on both the inlet and outlet which shall be permanently affixed to ensure proper spacing and alignment for the meter. Meter boxes shall also be provided with an ASSE 1024 approved inline, dual check valve located behind the meter. For boxes not utilizing a 1 inch meter, adapters shall be provided to accommodate a 5/8 x 3/4 inch meter. All fittings and connections shall be "no lead" brass conforming to UNS C89833 as per ASTM B584.

A "no lead" brass curb stop with compression connections shall be installed within 2 feet of the inlet connection. The curb stop may be buried without a box above it.

One 2 inch or 6 inch grade adjuster may be used when needed to meet final grade, however, no grade adjusters are permitted on new construction projects. Grade adjusters shall be cast iron. Grade adjuster and box shall be by the same manufacturer.

9. 1 ½ and 2 inch Water Services: 1 1/2" and 2" meter boxes shall be concrete or light weight polymer concrete as indicated in the Standard Details. Meter boxes for 1 ½ and 2 inch water services shall provide a cover opening of 24 X 36 inches and boxes shall measure at least 30-inches in depth and provided in straight wall arrangement. Standard meter box covers shall bolt down to the box, and all polymer cement covers shall be provided in solid configuration with a 2 inch diameter transmitter hole, and with the words, "Water Meter" cast into the lid. The meter box covers shall be provided with 2 stainless steel bolts in penta head configuration for security. To ensure positive discharge, the box should be tied into the existing storm drain system, or shall have an open bottom to allow drainage through a 6-inch stone base. All meter box covers for potable water service shall be provided in standard concrete gray or black color.

   Custom setter piping and fittings for 1 ½ and 2 inch water meters shall be constructed from "no lead" brass (meeting UNS C89833 as per ASTM B584) and copper tubing and shall be equipped with a lockable by-pass flanged ball valve and flanged angle meter ball valves All applications shall have a separate above ground backflow preventer.

10. Water services greater than 2-inches: Water services greater than 2-inches shall have the meter and bypass line located within a precast concrete vault. All piping and valves shall have flanged connections. There shall be isolation gate valves on both sides of the meter as well as one on the bypass line. Gate valves within the vault shall meet the above requirements of AWWA C509 for non-rising stem

gate valves, but shall be provided with hand wheel operators. A standard buried gate valve with 2-inch nut shall be provided between the main and the vault. Link seals shall be used where the pipe enters and exits the vault.

11. Meter Vaults: Meter vaults and access doors shall meet HS-20 loading requirements and shall be located outside of travel areas. Pedestrian rated covers shall not be used regardless of where they are located. The access double doors shall be aluminum with a flush drop lift handle, stainless steel hinges and bolts, a stainless steel slam lock, an automatic hold open arm, and compression springs to allow for easy opening. Vaults shall be approximately 9-feet by 12-feet. To ensure positive drainage, the vault shall be tied into the existing storm drainage system. If positive drainage is unobtainable, a sump pump shall be located and operated in the vault.

605 Irrigation Systems

1. All irrigation systems shall be provided with privately maintained lead free reduced pressure principle backflow prevention installed in accordance with the NC Plumbing Code and the Foundation for Cross Connection Control and Hydraulic Research. Reduced pressure zone backflow preventers shall be installed above ground in an insulated box as shown by the details.

2. All irrigation systems within public street right of way require an encroachment agreement from the Town or NCDOT prior to installation. Plans designating the location, size, material, and depth shall be submitted with the agreement application to the Inspection & Permits Department. If there is an approved site plan, it shall be referenced with the encroachment submittal to the State.

3. Pipe material for the mainline proposed to be used within the public right of way shall be Schedule 40 PVC or greater. A distance of at least 3-feet shall be provided from the back of curb or edge of asphalt in a ditch section. A minimum depth of 2-feet of cover shall be provided and all heads shall spray away from the street.

4. All street crossings of irrigation systems shall be encased in ductile iron or steel conduit. Irrigation systems installed in the medians of Town maintained roadways must also have French drains installed behind the curb and gutter which are piped to a storm system.

5. There shall be no interconnections between the Town’s water system and any private water sources (wells).

606 Testing and Inspections

A. General

1. All materials must be approved by the Infrastructure Inspector prior to installation. Materials rejected by the Infrastructure Inspector shall be immediately removed from the job site.

2. The Contractor shall furnish all materials, labor, and equipment to perform all testing and inspections to the satisfaction of the Infrastructure Inspector or Water Quality representative. The Town shall provide water for testing purposes on water mains in accordance with Town Standard Procedure 4, Control and Monitoring of Water System Flow Activity.

B. Testing

1. Pigging of Water Mains

   a) All new water mains shall be pigged as a part of the testing procedure. Pigging shall take place at the conclusion of pipe installation utilizing the initial water fill or loading of the pipe. Pigging shall take place prior to any introduction of chlorine solution to the pipe. The Contractor shall use a 5 pounds/cubic foot density polyethylene pig and shall write their company name and the street name where the work is taking place in a permanent manor on the pig. A minimum velocity of 2 feet per second shall be maintained during pigging operations. In larger water mains, a swab may be utilized with prior approval from the Water Resources Director.

2. <u>Hydrostatic Testing</u>

   a) No valve in the Town water system shall be operated without authorization in accordance with the Town and by a Town employee. Advance notice of at least 24 hours shall be provided prior to testing. A section of line that is to be hydrostatically tested, shall be slowly filled with water at a rate which will allow complete evacuation of air from the line. Hand pumps shall not be used for the pressure testing of water mains. Taps used for testing purposes shall be removed after testing and repaired using a “no lead” brass plug.

   b) When filling the pipeline, it is very important to fill the line slowly to avoid undue impacts associated with surge and to allow air to evacuate the pipeline. After all air has been expelled from the water main, the line shall be tested to a pressure of 200 psi as measured at the lowest elevation of the line for a duration of 2 hours. The testing period shall not commence until all air has been evacuated and the pressure has stabilized. The pressure gauge used in the hydrostatic test shall be calibrated in increments of 20-psi or less. The pressure gauge shall be liquid-filled and indexed for an operating range of 300-psi or

less with a minimum dial size of 4 inches. At the end of the test period, the leakage shall be measured with an accurate water meter.

c) No leakage shall be allowed. If leakage is present, repair of the water main and additional testing shall be conducted until the standards are met.

d) Once testing and sampling have been completed, Contractor shall verify with Town that all valves have been opened.

3. Disinfection

a) All additions or replacements to the water system shall be disinfected with chlorine in conformance with AWWA C651 before being placed in service under the supervision of the Town's Infrastructure Inspector in the following manner:

1) Taps shall be made at the control valve at the upstream end of the line and at all extremities of the line including valves.

2) A solution of water containing 70% High Test Hypochlorite (HTH) available chlorine shall be introduced into the line by regulated pumping at the control-valve tap. The solution shall be of such a concentration that the line shall have a uniform concentration of not less than 50-ppm and not more than 100-ppm total chlorine immediately after chlorination. The chart below shows the required quantity of 70% HTH compound to be contained in solution in each 1000 feet section of line to produce the desired concentration from 50-ppm to 100 ppm.

Required Hypochlorite Concentration

Pipe Size (inches)	Pounds of High Test Hypochlorite (70%) to reach 50-ppm *per 1,000 feet of line*	Pounds High Test Hypochlorite (70%) to reach 100-ppm *per 1000 feet of line*
6	0.88	1.76
8	1.56	3.12
10	2.42	4.84
12	3.50	7.00
14	4.76	9.52
16	6.22	12.44
20	9.76	19.52
24	14.00	28.00
30	21.86	43.72
36	31.47	62.94
42	42.85	85.70

3) The HTH Solution shall be circulated in the main by opening the control valve and systematically manipulating hydrants and taps at the line extremities. The HTH solution must be pumped in at a constant rate for each discharge rate so a uniform concentration will be produced in mains.

4) HTH solution shall remain in lines for no less than 24 hours or as directed by the Town's Infrastructure Inspector.

5) Extreme care shall be exercised at all times to prevent the HTH solution from entering existing mains.

6) Free residual chlorine after 24 hours shall be at least 10 ppm or the Infrastructure Inspector will require that the lines be re-chlorinated.

4. Flushing

a) Flushing of lines may only proceed after 24 hours of disinfection contact time and as directed by Town staff, provided the free residual chlorine analysis is satisfactory.

b) At the completion of disinfection, chlorinated water flushed from the water main shall be disposed of in conformance with all Federal, State and local regulations.

c) In accordance with all applicable regulations, a neutralizing chemical shall be applied to minimize chlorine residual in the flushing water before discharging from the water main, unless an alternate plan is submitted in writing and approved by the Town.

d) Water used for disinfection shall be flushed from the water main until the chlorine residual concentration is below 5-ppm before initiating sampling.

5. Bacteriological and Turbidity Sampling

a) Bacteriological sampling shall be utilized to verify disinfection prior to placing a newly constructed water main in operational service. Bacteriological sampling shall consist of 2 consecutive sets of acceptable samples taken at least 24-hours apart and collected from each 1,200-ft section of water main and all dead ends and branches as outlined by ANSI/AWWA C651.

b) For the first round of sampling, the requested laboratory analysis shall be specified as follows: "Bacteriological Test and Turbidity." For the second round of testing, the laboratory analysis shall be specified as, "Bacteriological Test Only."

c) Samples for laboratory analysis shall be collected by the Town's Infrastructure Inspector after flushing is completed. The Contractor shall set up sampling stations and furnish the sample bottles, the testing agency and shall secure these samples. The Contractor shall make arrangements with the laboratory that all test results be submitted directly to the Town's Infrastructure Inspector or other designee approved by the Water Resources Department. All costs for laboratory testing shall be borne by the Contractor. Samples shall be taken at 2000 feet intervals, at the end of the main, at each branch connection, and each side of all cut-in connections.

d) The laboratory secured for testing shall be certified by the State Laboratory of Public Health. All sample bottles for bacteriological sampling provided by the laboratory shall be sterilized and treated with a dechlorinating agent, such as sodium thiosulfate. Samples for turbidity shall be taken in plain sterilized bottles from the lab, which are separate from the bottles provided for bacteriological testing. The sample bottles shall be provided with tamper proof seals that will be adhered to the bottles by the Town's Infrastructure Inspector. The Infrastructure Inspector shall provide a sample identification number, job title and an identification of Phase 1 or Phase 2 sampling that will be provided on the tamper proof custody seal. The bottles and tamper proof custody seals shall be accompanied by a chain of custody form provided by the certified laboratory conducting the testing. All sample identification numbers, job titles, and Phase 1 or Phase 2 testing identification from the custody seal shall be recorded on the chain of custody forms by the Infrastructure Inspector.

e) All samples shall be collected in compliance with the sampling protocols provided by the certified laboratory. The samples shall be kept in a cooler provided by the Contractor at approximately 40-degrees Fahrenheit or 4-degrees Celsius and delivered to the certified lab for testing as soon as possible. The time at which the sample is taken shall be recorded on the chain of custody form by the Infrastructure Inspector. Any samples processed at the laboratory more than 30-hours following collection shall be declared invalid, i.e. samples shall be submitted to the lab within 24-hours of collecting them.

f) All first round samples shall be tested for bacteriological quality and turbidity in accordance with standards established by NCDEQ and AWWA. If turbidity exceeds 1.0 NTU, the sample shall fail and the system shall be re-flushed before initiating a new round of testing.

g) If the phase 1 sample results for bacteriological quality and turbidity are acceptable, then a second set of samples can be collected at least 24-hours following the first sample collection. No additional flushing other than required to obtain a representative sample will be allowed prior to collecting the second set of samples.

h) The second set of samples shall be tested for bacteriological quality only. All custody seals and chain of custody forms shall identify the second round samples as “Phase 2” testing to notify the lab that the first set of samples have already been evaluated and received a satisfactory laboratory analysis.

i) At the completion of sampling, the total chlorine concentration shall be at least 2-mg/L and no higher than 4-mg/L before the system can be made operational.

j) If three successive test results are unsatisfactory, the Contractor shall immediately re-chlorinate lines and proceed with such measures as are necessary to properly disinfect the lines.

k) The new water system shall be valved off from the existing system until a satisfactory bacteriological laboratory analysis has been obtained and the Infrastructure Inspector has authorized the use of the new water system.

l) Water mains shall be placed into service within 72 hours of passing bacteriological analysis requirements. If no activity is anticipated on a water main after it is placed into service, the contractor shall notify the Town’s Operations Manager.

6. Tracer Wire and Marker Tape Testing

   Testing of the tracer wire and tape shall be performed by the Contractor at the completion of the project to assure they are all working properly. It is the Contractor’s responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise non-locatable units shall be replaced.

607 Repair and Abandonment

1. Joint leaks of Ductile Iron Pipe shall be repaired by using a bell joint leak repair clamp approved by the Town or otherwise replacing the damaged pipe and reconnecting with a mechanical joint sleeve connection.

2. Line Breaks or Punctures shall be repaired by a full circle repair clamp as approved by the Town or otherwise replacing the damaged pipe and reconnecting with a mechanical joint sleeve connection.

3. Line Splits or Blow Outs shall be repaired by replacing the damaged section with ductile iron pipe with a restrained sleeve connection at each end.

4. Asbestos Cement Pipe to PVC or Ductile Iron Pipe transitions shall use a Krausz Hymax or Romac Macro HP coupling with different end diameters sized specifically for the pipe materials and pipe outside diameter at each end.

5. All water main point repairs shall be replaced with DIP in accordance with these Specifications and backfilled with crush and run stone compacted to 95% maximum dry density as specified elsewhere in the Standard Specifications.

6. Water Service Line Repairs

   a) A water service line severed between the water main and the water meter shall be repaired using new type K copper tubing and bronze or “no lead” brass 3 piece compression unions.

   b) A corporation stop pulled out of a PVC pipe water main shall have a new service saddle and a new “no lead” brass corporation stop installed on the water main.

   c) A corporation stop pulled out of a ductile iron pipe shall have a full circle repair clamp placed over the old tap hole. A new tap shall be made and a new “no lead” brass corporation stop installed on the water main.

7. Abandonment of Existing Water Mains

   a) Existing water mains located outside of road sections shall be removed, unless otherwise directed by the Town. All materials and labor shall be provided by the contractor.

   b) Grout filling and abandoning in place may be allowed with prior approval from the Director of Water Resources.

SECTION 700
WASTEWATER COLLECTION SYSTEMS

701 Gravity Sewer

A. Design

1. Main Location

a) All public sanitary sewer mains shall be installed in dedicated street right of way or in dedicated utility easements. Mains within easements shall be centered within the easement. Mains located along NCDOT roads shall be placed outside of NCDOT right of way.

b) In preparing engineering design plans, all elevations shall be tied to NC grid system and the benchmark shall be described on the plans. A field survey of all waterways and waterbodies within project area must be performed, including but not limited to: creeks, streams, rivers, lakes, ponds, ditches, and culverts. Survey must include adequate points to accurately represent the cross section of the waterway/waterbody, i.e. top of bank, toe, centerline, etc.

c) Construction Drawings shall be prepared by or under the direct supervision of a professional engineer, licensed in North Carolina. Design shall conform to all standards and guidelines established by the Town and NCDEQ. Any design that does not meet minimum requirements set forth by NCDEQ and 15A NCAC 02T rules shall require a variance approval from NCDEQ. Plans shall indicate deflection angles at all manholes.

d) All private sewer collection mains inside the Town service area that will connect or are planning to discharge into the Apex sewer system shall comply with all Town of Apex design, siting and installation criteria outlined herein. The Owner of the private sewer collection system shall meet all State design requirements and obtain a State permit to operate the private system.

e) Gravity mains shall be installed in dedicated public right of way (not alleys or roundabouts) or in dedicated utility easements as follows:

Pipe Depth*	Permanent Easement Width	Town Road R/W
8-ft or less	20-ft	Allowed
8-ft – 15-ft	30ft	As Specified by the WR Department
15-ft – 20-ft	40-ft	Not Allowed
Deeper than 20 ft	As Specified by the WR Department	Not Allowed

*Depth of the sewer main shall be measured from the top of the pipe to the final grade or road subgrade at the deepest point between manholes.

Dedicated easements for sewer mains and appurtenances shall be recorded as “Town of Apex Public Sanitary Sewer Easement”. Town of Apex sewer easements shall contain only Town of Apex utilities unless otherwise approved by the site plan or an encroachment agreement. Sewer mains shall be centered in the easement. Easements shall be acquired by the Developer (unless utility is designed as part of a Capital Improvement Project) prior to construction approval.

Easements must be clearly labeled as “public” or “private”.

If the sewer main is located within the road right-of-way, a clear width equal to or greater than the easement width required must be available. If adequate width is not available within the right-of-way, additional easement outside of the right-of-way must be maintained. For example, if a sewer main normally requiring a 20 foot easement is installed 5 feet inside of the right-of-way, an additional 5 feet of easement must be obtained outside of the right-of-way to provide a clear total width of 10 feet on each side of the pipe.

f) The minimum width of a permanent easement that contains sanitary sewer and storm sewer shall be 30 feet. There must be a separation of 10 feet between the outside of each pipe and 10 feet from the centerline of the pipe to the easement line.

g) The minimum width of a permanent easement that contains sanitary sewer and greenway shall be 15 feet in addition to the width required in the table above. There must be a separation of 10 feet between the sewer main and the edge of pavement and at least 10 feet from the centerline of the pipe to the easement line.

h) No structures, equipment, retaining walls, embankments, impoundments, pavement, landscaping, fill, or other elements that would inhibit maintenance operations shall be constructed within a sewer main easement as outlined in Section 200. Fences may be allowed across easements provided that appropriate access gates or removable panels have been installed to allow utility maintenance. Fences shall not be installed parallel within utility easements. In all cases, Town of Apex Operations Staff shall have access to secured access gates. Fill or cut slopes are not allowed to extend into easements without full development plan approval or an approved encroachment agreement from the Town of Apex, see Section 200 for further information. All such pre-existing or planned conditions as noted herein that would impact operations and maintenance within the noted sewer main easement shall be noted and disclosed during the site plan approval process. Pre-existing conditions that are not disclosed during

the site plan review may nullify the approval and require relocating the sewer easement where there are no existing conflicts.

i) Where public sanitary sewer mains are installed within easements crossing private property, the Town's Water Resources Department shall have the right to enter upon the easement for purposes of inspecting, repairing, or replacing the sewer main and appurtenances. Where paved private streets, driveways, parking lots, etc. have been installed over public sewer mains, the Town of Apex shall not be responsible for the repair or replacement of pavement, curbing, landscaping, etc. which must be removed to facilitate repairs. The Water Resources Department shall excavate as necessary to make the repair, and shall backfill the disturbed area to approximately the original grade. Replacement of privately owned pavement, curbing, walkways, etc. shall be the responsibility of the property owner and/or Homeowner's Association.

j) Easements shall be accessible from public rights-of-ways. If easement is not accessible perpendicular from right-of-way due to steep slope, environmental feature, or other obstacle, additional easement may be necessary.

k) Sewer line easements shall be graded smooth, free from rocks, boulders, roots, stumps, and other debris, and seeded and mulched upon the completion of construction. Easements across sloped areas shall be graded uniformly across the slope to no steeper than a 4 to 1 ratio.

l) Mains paralleling a creek shall be of sufficient depth to allow lateral connections below the stream bed elevation. The top of the sewer main and laterals shall be at least three feet below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.

m) Mains shall not be installed under any part of water impoundments or area to be impounded. Sewer mains shall not be installed through, above, or below any retained earth structure. Sewer main location and depth shall not be within the theoretical 1:1 slope of any impoundment dam or structure, or shall maintain a minimum of 10’ horizontal separation from the toe of slope, whichever is greater. The entire easement shall be outside of the toe of slope, unless prior approval is obtained from the Water Resources Director.

n) Sewer profile shall follow natural topography and road grade. Sewer designed against natural grade or road grade shall only be allowed if

approved by the Water Resources Director and no practical alternative is available.

o) The following minimum horizontal separations shall be maintained:

1. 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)

2. 50 feet from wetlands and any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below)

3. 20 feet from any other stream, lake, or impoundment (except as noted below)

4. With approval directly from PERCS, the following separations may be acceptable when water main standards are implemented:

    a. All appurtenances shall be outside the 100 foot radius of wells.

    b. 50 feet from private wells (with no exceptions)

    c. 50 feet from public water wells (with no exceptions)

    d. Where the required minimum separations cannot be obtained, ductile iron pipe shall be used with joints equivalent to water main standards.

p) Sewer mains shall always be extended along any and all natural drainage courses/draws that are located within the property line boundaries of the proposed development. This sewer shall be extended to all adjacent upstream property lines.

    1) Sewer design shall account for future upstream development based on the current land use plan.

    2) Project shall include evaluation of existing downstream sewer capacity. <u>This evaluation shall address the capacity of all sewer collection and truck sewer systems that will be impacted downstream of the new development and/or redevelopment.</u> If any downstream sewer segments exceed 50 percent full, but are less than 65% full, the Town will evaluate and determine if upsizing is required. If any downstream sewer segments exceed 65 percent full, the

sewer main must be upsized or re-installed at a greater slope to allow for greater flow through the pipe. All improvements must be made the full length, from manhole to manhole.

3) The most upstream manhole shall be designed and located so that all upstream properties will have access to connect with future sewer mains. Depths shall be evaluated so that streams, roads, culverts, and any other features that must be crossed by future upstream sewer mains can do so and still achieve the required minimum cover on top of the sewer main.

q) Gravity sewer mains shall be deep enough to serve the adjoining properties and allow for sufficient slope in lateral lines. Gravity sewer pipe shall have the following minimum covers:

1) 3 feet from the top of pipe to finished subgrade in roadways.

2) 3 feet from the top of pipe to finished grade outside roadways.

r) Sewer mains that do not meet minimum cover stated above or the table in section A.1.e) are required to be ductile iron for the entire run between manholes. Steel casing and/or concrete may also be required for protection, at the direction of the Water Resources Director.

s) In all cases where fill material is added above existing sewer mains, the Engineer of Record shall prepare a structural analysis of the existing pipeline and determine if it is capable of supporting additional loading. If the additional fill material exceeds AWWA, DIPRA, UNIBELL and/or manufacturer standards for loading, the pipeline shall either be reinforced to adequately support the additional loading or replaced with a ductile iron pipe rated to support the added loading.

t) Separation Between Sanitary Sewer and Storm Water Pipes:
Sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or quick setting, minimum 500-psi, non-excavatable flowable fill that meets or exceeds NCDOT Specifications.

u) Separation Between Sanitary Sewer and Sewer Force Main:
There shall be a minimum 7 foot horizontal separation between parallel gravity and force mains when the depth of installation is 8-ft

or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to 10-ft depth of installation.

v) Separation Between Sanitary Sewer and Water Main

1) Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 5-ft lateral separation, and water line at least 18-inches above sanitary sewer line measured vertically from top of sewer pipeline to bottom edge of water main.

Crossings (Water Main Over Sewer): All water main crossings of sewer lines shall be constructed over the sewer line in conformance with Town of Apex Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance is not maintained, the water main and sanitary sewer main shall:

a. Both lines shall be constructed of ductile iron pipe with joints in conformance with water main construction standards.
b. The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole.
c. The void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sanitary sewer crossings of potable water mains.

2) Crossings (Water Main Under Sewer Line): Allowed only as approved by Town of Apex, when it is not possible to cross the water main above the sewer line. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and the sanitary sewer shall be constructed of ductile iron in conformance with water main construction standards the entire run from manhole to manhole. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

w) Where concentrated sources of runoff (e.g., SCM discharge, FES discharge outlets, natural drainage ways, etc.) convey across existing or proposed Town of Apex Sanitary Sewer Easements, the applicant must design a rip rap lined channel across the full width of the easement.

2. Main Size, Slope and Design Criteria

a) Public gravity mains shall be a minimum of 8 inches in diameter.

b) Major interceptors shall be sized in accordance with the "Town of Apex Sewer Master Plan". In areas not included in the master plan, interceptors shall be designed based on the proposed land use (according to the Town's Comprehensive Growth Plan), using the following flow factors. At a minimum, all gravity sewer mains shall be designed and sized to serve the ultimate tributary buildout of the drainage basin.

Residential flow rates:

Land Use	**Flow Factor**
Single Family Residential	300 gpd per dwelling unit
Multi-Family Residential	250 gpd per dwelling unit

Non-residential flow rates:

Use flow factors as required by the North Carolina Department of Environmental Quality (at the time of this Specification revision, these flow rates are contained in 15A NCAC 02T .0114).

For all other flow rates not listed in Section ii above, use:

Land Use	**Flow Factor**
Office and Institutional	0.09 gpd/sq.ft bldg. space
Commercial	0.12 gpd/sq.ft bldg. space
Industrial	0.20 gpd/sq.ft bldg. space

c) The ratio of peak to average daily flow shall be 2.5.

d) Sanitary sewers shall be designed to carry the projected average daily flow at no more than 1/2 full. The minimum velocity for sanitary sewer lines shall be 2.5-fps.

e) Sanitary sewers shall be sized based on the Manning's Equation with Manning's roughness coefficient "n" = 0.013 or greater. Pipe diameter sizes used in the calculation of Manning's Equation shall be nominal pipe sizes.

f) The minimum grades for public sanitary sewers shall be as follows:

Minimum Slopes for Gravity Sewer Mains

Main Size *(diameter in inches)*	Minimum Slope V=2.5ft/s, depth 1/2 full *(feet per 100 feet)* *{standard required velocity}*
8	0.52
10	0.39
12	0.30
14	0.25
15	0.23
16	0.21
18	0.18
21	0.15
24	0.12
27	0.11
30	0.09
36	0.07
42	0.06
48	0.05

Note1: All minimum slopes based on Manning's Equation
Note2: Manning's coefficient n = 0.013 used for all computations

g) The minimum grade for the uppermost reach of a sanitary sewer line shall be 1% regardless of sewer line size.

h) The maximum grade for sanitary sewers is 10%. The maximum velocity in sanitary sewers is 15 ft/sec. These limits may only be exceeded with the approval of the Director of Water Resources and the incorporation of the following provisions, which apply to all sewers either designed or installed at grades equal to or exceeding 10%:

1) All sewers with a grade of 10% or higher must have the downstream run of pipe installed with ductile iron pipe.

2) High velocity manholes shall be used on all sewers with a grade of 10% or higher. High velocity lines cannot tie directly to an existing line and must proceed 180^{o} through the invert into the downstream line.

3) Concrete thrust collars shall be installed on all sewers designed at grades of 10% or higher. The anchors shall be installed at the following spacing:

   a. Not over 36' center to center on grades from 10% to 25%
   b. Not over 24' center to center on grades from 25% to 40%
   c. Not over 16' center to center on grades exceeding 40%

4) The Town reserves the right to require all high velocity requirements outlined herein for sewer lines either designed or installed at grades of 10% or greater, regardless of the flow velocity. In cases where the design grade established on the sewer design plan is exceeded during construction and the 10% threshold is exceeded, all high velocity requirements shall apply without waiver.

i) 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.

j) All pipe diameter changes shall occur only in manholes, with the invert of the larger pipe lowered sufficiently to maintain the same energy gradient. An approximate method of obtaining this result is to place the crown of the incoming pipes may be designed for an elevation at or above the crown of the outgoing pipe.

k) All transitions of pipe material, pipe separations, grade changes, pipe thicknesses and all angular deflection changes shall occur only at manholes.

l) Pipe trench excavation and backfilling shall be performed in accordance with Section 0450 of these Specifications.

m) Gravity sewer downstream from a connection point with a force main shall be lined with 401-type ceramic epoxy for a minimum of 1,200 linear feet.

n) The minimum angle between inlet and outlet pipes in a manhole shall be 90 degrees.

B. Materials

Materials specified herein are acceptable for sewer service as described. Sanitary sewer mains shall conform to the following criteria:

Diameter (in)	Depth (ft)*	Material
Any	≤ 4	DIP
8 – 15	4 ≤ 13	PVC SDR 35 or C900 DR 18
8 – 15	13 < D ≤ 16	PVC C900 DR 18 or DIP
> 15	Any	DIP
Any	> 16	DIP

*Depth of the sewer main shall be measured from the top of the pipe to the final grade or road subgrade at the deepest point between manholes.

1. Ductile Iron Pipe

Material Specifications

Ductile Iron Pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DIP Sewer Mains

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
8 -inch	type 1	350 psi	3-16 feet
8 -inch	type 4	350 psi	> 16 feet
10-12 -inch	type 1	350 psi	3-16 feet
10-12 -inch	type 4	350 psi	16-20 feet
10-12 -inch	type 5	350 psi	> 20 feet
14-20 -inch	type 4	250 psi	3-20 feet
14-20 -inch	type 5	250 psi	> 20 feet
14-20 -inch	type 5	350 psi	As Directed
24-30 -inch	type 4	250 psi	3-20 feet
24-30 -inch	type 5	300 psi	> 20 feet
24-30 -inch	type 5	350 psi	As Directed
36-42 -inch	type 4	300 psi	3-20 feet
36-42 -inch	type 5	350 psi	> 20 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

In cases where thickness class designation of ductile iron pipe is specified, the corresponding thickness class designations are as outlined in the following table.

The following table lists approved manufacturers of DIP and DIP fittings that are allowable for installation within the Town's system.

Product Category	Approved Manufacturer	Model/Series	Pressure/Load Rating	Reference Standard	Requirements
Ductile Iron Pipe 8-inch & 10-inch Diameter (and 4-inch and 6-inch services) Cement Mortar Lined	US Pipe	Tyton Joint	350 psi	AWWA C150 and C151	Cement mortar lined with exterior bituminous coating. McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Pipe 12-inch and Larger Diameter Protecto 401 Lined	US Pipe	Tyton Joint	250-350 psi	AWWA and DIPRA Standards	40-mils of Protecto 401 Lining (lining must be less than 1 year old); McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Fittings 8-inch & 10-inch Diameter (and 4-inch and 6-inch services) Cement Mortar Lined	Sigma	Mech. Joint	350 psi	AWWA C110/C111 and AWWA C153	Shall always meet or exceed pipe pressure rating
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			
Ductile Iron Fittings 12-inch and Larger Diameter Protecto 401 Lined	Sigma	Mech. Joint	250-350 psi	AWWA and DIPRA Standards	Shall always receive interior Protecto 401 Lining to meet or exceed main line pipe standards. (401 lining must be < 1yr old)
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			

Ductile Iron Pipe Thickness Class

Pipe Diameter	Pressure Class	Nominal Thickness (inches)	Minimum Corresponding Thickness Class
8	350	0.25	50
10	350	0.26	50
12	350	0.28	50
14	250	0.28	50
16	250	0.30	50
18	250	0.31	50
20	250	0.33	50
24	250	0.37	50
24	300	0.40	51
30	250	0.42	51
30	300	0.45	52
36	300	0.51	52
36	350	0.56	53
42	300	0.57	52
42	350	0.63	53

Pipe joints shall be of the push-on type as per AWWA C111.

For 10-inch diameter and smaller gravity sewer mains, pipe lining shall be cement mortar with a seal coat of bituminous material, all in accordance with AWWA C104.

For 12-inch diameter and larger gravity sewer mains, all ductile iron pipe and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, as manufactured by Protecto 401. The interior coating shall be applied at a nominal dry film interior thickness of 40-mils. All DIP bells and spigots shall be lined with 8-mils of joint compound by Protecto 401 or approved equal applied by brush to ensure full coverage. All pipe supplied with Protecto 401 interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected and required to be replaced. Patching of Protecto 401 coating defects after installation shall not be approved. Protecto 401 lined pipe must be installed within one year of the application date on the pipe.

All buried DIP and fittings shall have bituminous coating on the exterior surface in accordance with AWWA C151/ANSI A21.51. The seal coat

shall be a coal tar epoxy lining and shall be Indurall Coating, Inc. “Ruff-Stuff”, Kopper’s Company, Inc. “Bitumastic No. 300-M” or approved equal. Pipe shall be supplied in minimum 20-ft lengths.

All ductile iron pipes shall be marked in conformance with ASTM A-746.

Pipe material and manufacturer must have a supplier within 200 miles of the Town of Apex.

2. Solid Wall PVC Pipe

Material Specifications

PVC Pipe shall be solid wall and made of PVC plastic having a cell classification of 12454 or 12364 (with minimum tensile modulus of 400,000 psi) as defined in Specification D1784. PVC pipe shall have integral wall bell and spigot joints for the conveyance of domestic sewage and shall be supplied in 20 ft lengths. Fittings shall be made of PVC plastic having a cell classification of 12454-B, as defined in ASTM D1784.

All PVC gravity sewer pipe and PVC fittings up to 15-inches in diameter shall be manufactured in accordance with the latest version of ASTM D3034. All solid wall PVC pipe installed at diameters from 18-inches to 27-inches in diameter shall be manufactured in conformance with ASTM F679 and provided at minimum pipe stiffness of 115-psi. Fittings must be manufactured by pipe supplier or approved equal, and have bell and/or spigot configurations compatible with that of the pipe. PVC pipe shall be installed in accordance with the requirements of this Specifications manual and ASTM D2321.

All PVC pipe up to and including 15 inches in diameter shall have a maximum Standard Dimension Ratio (SDR) of 35 for depth of installation no shallower than 4-ft of cover from the pipe crown and no deeper than 13-ft measured from the bottom of the pipe. All solid wall PVC pipe for depth of installation greater than 13-ft shallbe C900 DR18. Solid wall PVC pipe shall not be approved for depths of installation greater than 20-ft. All solid wall PVC pipe shall be marked and certified in conformance with ASTM D3034 or ASTM F679 and all AWWA standards.

C. Sewer Main Installation

1. General Requirements

a) Pipe trench excavation and backfilling shall be performed in accordance with Section 0450 of these Specifications.

b) Transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes. Pipe crowns shall be matched for changes in pipe sizes.

c) All sewer mains installed with less than 4 ft of cover or deeper than 20-ft shall be ductile iron pipe.

d) Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be covered and protected when pipe laying is not in progress to prevent debris from entering the pipe.

e) Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected.

f) Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

g) No bells or connections shall be within any waterway crossing area.

h) Sewer mains shall not be installed within roundabouts.

702 Manholes

A. Design

1. Manhole Location, Siting and Design

a) Manholes shall be spaced at a maximum distance of 400 feet.

b) Manholes shall be installed at each deflection of line and/or grade. The flow channel through manholes shall have a uniform and smooth finish free of irregularities or obstructions. The invert channel shall conform to the shape and slope of the entering/exiting sewer line. Either pre-cast or brick and mortar inverts may be used. Mortar shall be mixed in a clean, tight mortar box, or in an approved mechanical mixer and used within 45 minutes of mixing.

c) A minimum drop of 0.2 feet must be maintained between the invert into and out of the manhole. The benches shall be sloped so as to prevent sedimentation. The inverts from intercepted cross lines shall be tied into the main flow line wherever possible, so as to provide a smooth transition. Wherever such cross lines tie-in at a substantially higher elevation than that of the downstream invert, the connecting line shall extend into the manhole a sufficient distance to enable the flow to spill into the flow line rather than onto the invert bench.

d) On dead-end manholes receiving service connections, the invert must be constructed and the invert flow line shall extend through the manhole so that all flow entering the manhole shall be readily conveyed downstream.

e) Free falls of wastewater flow into the manhole invert from incoming sewer mains shall not be allowed, except under limited circumstances.

f) In certain isolated circumstances standard free drops may be allowed, not exceeding 24-inches, when pipe diameter changes occur at a manhole. In these cases, the smaller diameter pipe crown shall be positioned no higher than the larger diameter pipe crown to limit the drop. When free drops are necessary due to pipe size changes, the Contractor shall take preventive measures to prevent free drops into the manhole invert, such as building a flume or trough up to the incoming invert, or piping the flow to the primary invert flow channel.

g) Drop manholes are not allowed without the written approval of the Water Resources Department. While certain physical constraints may dictate the need for drop manholes, they may not be used merely to decrease

trenching depth. Upstream slope changes shall be used to avoid the need for drop manholes.

h) Manholes shall not be obstructed from view or access. It is illegal to bury or obstruct access to manholes. Manholes shall not be installed within roundabouts.

i) Manhole covers shall be elevated as follows:

1) Roadways: Manholes installed in roadways and road shoulders shall be installed with the cover flush with the top of pavement.

2) Outside of Roadways: Manholes installed outside of roadways shall be elevated at least 12 inches above the surface grade and/or at the same elevation of the road travel lane unless otherwise approved by the Water Resources Director.

3) Wooded Outfalls: All manholes installed in wooded, forested or brushy areas shall be elevated at least 24 inches above the surface elevation.

4) 100-Year Flood Zone: All manholes located within the 100-year flood elevation shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.

5) 100-Year Culvert Headwater Depth: All manholes located within a 100-year culvert headwater staging area shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.

6) Well Maintained Areas: All manholes installed in well maintained areas, such as yards, sidewalks or otherwise inside an improved right-of-way shall be installed flush with the finished surface.

j) Manholes used in outfalls and other non-traffic bearing areas shall be constructed with a flat top and outside steps.

k) Manholes shall be provided without interior steps.

l) When connecting a new sewer main to an existing main, the connection shall be established with a “Doghouse” type of manhole inserted over the existing main. Doghouse manholes shall only be installed on existing DIP or PVC mains.

m) Grade rings shall not exceed 6 inches.

2. Manhole Sizing

a) Manholes shall be sized as shown in the following table. The next larger size shall be required if the pipe size, depth, or number of main line connections warrants a larger size. In consideration of main line connections, all will be considered regardless of type, whether inside drop, outside drop, force main or standard connection.

Manhole Sizing Guide

Manhole Size	**Maximum Allowable Pipe Size, Single In**	**Maximum Allowable Pipe Size, Multiple In**	**Maximum Depth with Extended Base**
(diameter)	*(diameter)*	*(diameter)*	*(invert to rim)*
4-ft	8-12 inches		12-ft[1]
5-ft[4]	14-24 inches	8-12 inches	12-ft to 18-ft
6-ft[4]	30-36 inches	14-24 inches	18-ft to 24-ft
8-ft[4]	≥42 inches	30-36 inches	24-ft to 30-ft
10-ft[4]		≥42 inches	>30-ft

[1]Depths beyond 14-ft in roadways shall require a 5-ft diameter manhole with extended base.
[4]Due to the limited manhole wall area that could exist between the invert in and out, some manholes may require upsizing as directed by the Water Resources Department.

All manholes 5-ft in diameter shall be extended to surface elevation with no further reduction in diameter until the eccentric cone section.

Manhole transitions for 6-ft and larger diameter manholes are only allowed in the top 5-ft of the manhole. In no case shall the smallest barrel size be less than 5-ft diameter. At least 5-ft of vertical clearance shall be maintained above the pipe crown before transitioning to a smaller diameter riser, or transition shall not be utilized. An eccentric flat slab reducer from 6-ft diameter or larger manhole base sections to 5-ft diameter risers (non-paved areas) or eccentric cones (paved areas) shall be used to make any transition.

Manholes outside of paved areas that are 6-ft in diameter and greater and are too shallow to maintain 5-ft of vertical clearance above the crown of the pipe shall maintain the full manhole diameter up to the design surface elevation and be provided with a flat top slab cover with eccentric hole.

Manholes inside of paved areas that are 6-ft in diameter and greater shall be constructed with an eccentric, flat top reducer to 5-ft diameter and provided with a 5-ft diameter eccentric, tapered cone at the finished grade.

When the depth of the manhole is too shallow to maintain 5-ft of vertical clearance above the crown of the pipe a 3-ft tall eccentric, tapered cone shall be used without any additional 5-ft diameter risers.

B. Materials

1. Concrete Manholes

a) Manholes shall be precast concrete with a minimum compressive strength of 4000-psi and utilize minimum grade 60 rebar in compliance with ASTM C478. All 4-ft and 5-ft diameter manholes and all 6-ft diameter manholes in paved areas shall be provided with eccentric cone sections. Flat top manholes are required in outfall areas and for 6-ft and larger diameter manholes.

b) Precast concrete manholes shall meet all design and manufacturing requirements of ASTM C478 and all H-20 loading requirements. Minimum wall thickness shall be 5-inches and shall increase with depth and diameter in accordance with ASTM standards. The standard joint shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant. All lift holes must be plugged with non-shrinking grout after installation.

c) All manholes greater than 5-ft diameter shall have minimum 8-inch (6-inch for 4-ft diameter manholes), 4,000-psi concrete bottoms resting on a minimum of 12 inches of #57 stone. Sewer mains shall enter and exit radially through the manhole. Inverts shall be constructed with a width equal to the effluent pipe and a height equal to 1/2 that of the effluent pipe. Inverts shall be so finished with sufficient drop across the manhole to compensate for all resulting energy loss across the invert. Flat invert channels shall not be allowed. At each inlet and outlet of 8 inches or greater, resilient connectors or manhole boots shall be provided in conformance with ASTM C923. Rings and clamps are to meet standards of ASTM A167 and/or ASTM C923.

d) Precast manhole components shall not be installed, transported, or removed from the casting yard prior to reaching the minimum compressive strength of 4,000-psi and at least 7 days have elapsed since casting.

e) Manhole flat slab, eccentric reducers provided for 6-ft diameter and larger manholes shall be provided with minimum slab thickness of 12-inches. Flat slab, eccentric reducers shall not be allowed for manhole diameters less than 6-ft.

f) Manhole flat top slab covers for outfall manholes 6-ft diameter and greater shall be designed and manufactured for H-20 loading and provided in minimum slab thickness of 8-inches. Manhole flat top covers shall be provided with a minimum clear opening of 36-inches when utilized with a 36-inch clear span manhole frame and cover.

g) Manhole benches shall slope upwards from the spring line of the pipe to the projected level of the pipe crown at the manhole wall, or 8-inches above the spring line, whichever is less. Bowl type inverts recessed inside of precast benches shall not be accepted.

2. Manhole Frame and Cover Materials

a) Manhole Frames and Covers shall be Class 35 gray iron with "Sanitary Sewer" and the Town symbol forged into the cover as indicated in the details. Ring and cover shall be stamped with make and model. All manhole frames and covers shall be domestically made and manufactured in the USA from domestic iron.

b) Types

1) Manhole Frames and Covers in Paved Areas and some Unpaved Areas: For all installations in roadways or within the right of way, use Type 1 ring and cover, and place sufficient depth of concrete below the pavement around the ring to ensure contact with manhole. Type 1 covers shall be provided with 1 vent hole. Type 1 covers shall be designed for a proof load of 40,000 lbs. and be provided in Class 35B gray iron in conformance with ASTM A48. At a minimum, Type 1 manhole rings shall weigh 190 lbs. and the cover shall weigh 120 lbs.

2) Manhole Frames and Covers for Outfalls: For installation in outfall areas, with 4-ft and 5-ft diameter manholes use Type 2 ring and covers. Type 2 covers shall not be installed in areas subject to traffic loading. Type 2 covers shall be provided with an integrated frame and cover assembly in which the cover rotates away from the frame for access. The rotating assembly shall be provided with a cast in stainless steel rod assembly. Type 2 covers shall be provided with a minimum 24-inch clear span opening along the axis with the stainless steel rod assembly. Security shall be provided by 3 exterior cast lugs at ¾-inch thickness that allow padlock installation or bolting with 3 stainless steel bolts with stainless steel zinc plated nuts. Type 2 covers shall be made of Class 35B iron in conformance with ASTM A48 and designed for a proof load of 12,000 lbs. The frame and cover weight shall not be less than 60-lbs for the cover and 80-lbs for

the ring. The Type 2 frame and cover assembly shall be provided with a gasket that makes the cover assembly watertight when bolted at all three lugs. Type 2 covers shall be provided inside the 100-year flood elevation or other areas subject to flooding.

c) All castings shall be machined to give even and continuous bearing on the full length of the frame. Castings shall be free of porosity and blow holes. All manhole frames shall be bolted to the manhole, except in paved streets.

d) Manhole ring and cover shall be made by East Jordan Iron Works, US Foundry, Neenah Foundry Company, or approved equal.

e) Where deemed necessary in low areas of streets, solid manhole covers may be required to prevent surface water inflow into the sewer.

C. Installation

1. General Requirements

a) The downstream side of the last manhole(s) of a sanitary sewer line extension under construction shall be plugged by constructing a brick/block wall to prevent the passage of groundwater, runoff and sediment into the sanitary sewer system. All water upstream of the wall shall be pumped out of the sanitary sewer line and all sediment and solids shall be removed and properly disposed of by the Contractor. Water, sediment, and solids shall be removed every 30 days, or sooner if necessary, for the duration of the project. The wall shall not be removed until the line has been inspected by the Town to ensure that all possible points of inflow or infiltration have been eliminated. Failure to meet these requirements will be deemed a violation with fines up to $1,000.00 per day.

b) Manholes shall not be buried or hidden, which is a violation and subject to penalty by fines.

c) All manhole penetrations, whether sewer main or service lateral, shall be cored with a concrete coring machine. All pipe connections must be made with flexible watertight couplings or boots.

For new manholes, there shall be a minimum of 9-inches or ½ the pipe outside diameter (OD), whichever is greater, between the pipe hole openings. (Pipe hole opening is typically 4” greater than the pipe OD.) When the adjacent pipes are different sizes, the OD of the smaller pipe shall be used to determine the spacing requirement, but shall never be less than 9-inches.

For connections to existing manholes, there shall be a minimum of 9-inches or 3.5-inches plus ½ the OD of the existing pipe, whichever is greater, between the pipe hole openings.

d) All manhole sections shall be standard tongue and groove with rubber "O" ring or butyl rope sealant. All external manhole joints shall be wrapped with an approved joint seal material.

e) Each connection to a manhole shall be sealed watertight by means of a flexible sleeve or gasket type sealing system. The flexible sleeve type system, if used, shall be equal to Flexible Manhole Sleeve as manufactured by the Interpace Corporation. The gasket type system, if used, shall be equal to the PSX system as manufactured by the Press Seal Gasket Corporation. The sealing system shall be furnished by the manhole manufacturer.

f) Manholes shall be set on a base of 57 stone that is a minimum of eight (8) inches thick for four (4) foot diameter manholes and twelve (12) inches for five (5) foot diameter.

g) Backfill around manholes shall be placed uniformly in shallow layers and thoroughly compacted with mechanical tampers and with care taken to ensure against displacement of the structure.

h) All manhole rings shall be set in full mortar beds and bolted down. The rings with covers shall be set to the final grade indicated on the plans or as may be directed by the Town. Any rings and covers not conforming to the correct grade shall be adjusted by the Contractor as required. The exterior surface of all manholes shall be thoroughly cleaned of all grease, dirt, etc. All lifting lugs shall be removed and holes patched thoroughly with non-shrink mortar, color to match that of the manhole where such patches are exposed.

2. <u>Manholes Subject to Inundation</u>

a) Manholes subject to flooding shall be watertight and vented 24 inches above the 100-YR flood elevation. In flood prone areas, the manholes shall be vented at least every 1000-ft or every other manhole, whichever is greater.

b) The exterior of all manholes within the 100-year flood elevation and in wetland areas shall receive an exterior coating of an approved bitumastic coal tar epoxy or an approved epoxy coating at 40-mils to prevent weepage or attack by acidic soils. Individual joints shall be

wrapped with Conwrap, Conseal, or approved equal and approved by the Town prior to backfilling.

c) Anti-flotation design measures shall be implemented as required in flood prone areas.

3. Manholes Located on Large Collection Mains

The Town reserves the right to require all manholes located on interceptor or outfall mains 24-inches in diameter and larger to have the manhole interior and bench coated with an approved epoxy coating at 80-mils thickness. The epoxy coating shall be field applied and tested as described herein.

4. Force Main Discharge Manholes

All manholes located on gravity mains that serve or will serve as discharge points for sanitary sewer force mains shall receive an interior epoxy coating at 80-mils thickness. In addition to the receiver manhole, the Town reserves the right to require epoxy coating of the next two consecutive manholes downstream of the receiver manhole or all downstream manholes within 1200-lf of the receiver manhole,—See Section 800 for further information on force main discharge manholes.

5. Epoxy Coating

a) Surface Preparation: Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required).

Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

b) Installation: A minimum 80-mils thickness shall be field applied to new manholes (120-mils for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations.

Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

6. Labeling

a) The interior of each manhole shall be labeled during construction. Labels can be from the manufacturer (stencil, tag, etc.) or by the contractor (tag, permanent marker, paint pen, etc.). Label must include the manhole number according to the record drawings and must consist of letters at least 3 inches tall and must be located approximately 12 inches above the shelf of the manhole.

703 Service Connections

A. Design

1. General Requirements

a) All residential subdivision lots shall be served by gravity unless otherwise approved. If a pump is approved, it shall be privately maintained and must pump into either a service connection placed on the lot. The pump and force main (if needed) must have a note on the recorded plat indicating the following: "Privately maintained sewer pump and force main is required to serve this lot".

b) Service connections to the main lines shall be perpendicular to the main line and shall extend to the edge of the right of way or easement line. Direct taps shall be within the top quarter of the main, or within a

manhole. All single family residences and businesses shall have individual connections to the public sewer main. Sewer services may not cross private property if the Development is subject to UDO requirements.

c) Multiple service connections located outside public right of way or public easements are for private use only and will not be maintained by the Town. A private sewer permit from NCDEQ shall be required on all private collection systems prior to construction plan approval. A cleanout or manhole shall be installed within each serviced lot's right of way or easement for the Town's use, and shall extend a minimum of 6 inches above the finished grade.

d) Cleanouts are required on all services with a maximum spacing of 50 feet for four (4) inch lines and 100 feet for six (6) inch lines. The first cleanout from the main/manhole shall be maintained by the Town and shall be installed one (1) foot inside the right of way line or edge of easement. All cleanouts shall extend a minimum of 6 inches above finished grade with brass caps or meet the optional cleanout method requirements in accordance with the Standard Details. Town maintenance of sewer services shall terminate at the first cleanout.

e) Sewer cleanouts located in paved areas, which bear vehicle loading, must have ductile iron risers, ductile iron fittings and a traffic rated cast iron cover assembly.

f) All 4 inch services shall connect directly into a public sewer main or manhole, in the fronting street or into an easement within the property. All 6 inch service connections shall be into a manhole.

g) Service lines connected to manholes shall not be through the cone section or manhole joints. Service lines shall be installed 6" above, but no more than 30 inches above the invert or shall be installed with a standard drop. Multiple service connections shall not be maintained by the Town. For 6-ft diameter and larger manholes no service is allowed in the reduced diameter riser sections of the manhole.

h) The use of in-line wyes for service connections shall be required for all new construction. When connecting to existing sewer mains, service saddle taps will be allowable. Taps shall be at the 10 or 2 o'clock position, and shall not be top taps.

i) Service connections to mains at depths of 14-ft and greater shall utilize ductile iron pipe between the main and the cleanout, including a ductile iron wye for the cleanout stack. Location and angle of fittings shall be as shown in the standard detail drawings.

j) Where the flood level rims of plumbing fixtures are below the elevation of the manhole cover of the next upstream manhole in the public sewer, such fixtures shall be protected by a backwater valve installed in the *building drain*, *branch of the building drain* or *horizontal branch* serving such fixtures. Plumbing fixtures having flood level rims above the elevation of the manhole cover of the next upstream manhole in the public sewer shall not discharge through a backwater valve.

B. Materials

1. Pipe Materials

a) PVC Pipe shall be C900, schedule 40, or greater supplied in minimum 20-ft lengths. Schedule 40 PVC pipe shall be manufactured with a cell classification of 12454 in conformance with ASTM D1784. Schedule 40 pipes shall be manufactured to dimensional tolerances as specified in ASTM D1785 and rated for service conditions up to temperatures of 140-degrees Fahrenheit. The pipe may be joined by solvent weld in conformance with ASTM D2564.

Schedule 40 PVC pipe may be used for sewer services between 4 and 13 feet and shall require 4-inches of stone bedding extended to the springline.

PVC pipe and fittings for sewer laterals shall conform to ASTM D2665 “PVC Plastic Drain, Waste & Vent Piping” and shall be NSF approved. Laying lengths may be 10 or 20 feet with solvent weld type joints for Schedule 40 pipe or gasketed joint for PVC C900 DR18 pipe.

PVC C900 pipe shall be used in depths between 13 and 20 feet and shall require 6-inches of stone bedding extended 6-inches above the pipe crown.

b) Ductile Iron Pipe may be used for any depth sewer service but must be used for sanitary sewer services with less than 4 feet of cover or in excess of 20 feet of cover. Ductile iron services shall also be used in all cases where a well is located within 100-ft of the sewer service line. Ductile iron service piping shall be provided in conformance with the ductile iron piping standards outlined herein including cement mortar lining.

c) Any sewer service lateral deeper than 20 feet shall be pre-approved by the Director of Water Resources.

2. Sewer Service Fittings, New Construction

a) DIP Main with DIP Service
In-line wye fittings for ductile iron main lines joined with ductile iron service lines shall be typical ductile iron mechanical joint fittings as specified herein. In this case all fitting sizes shall conform to AWWA C153. Wye fittings through 10-inches in diameter shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Wye fittings for lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein for ductile iron pipe of the same sizing.

b) DIP Main with PVC Service
For ductile iron sewer mains to be joined with PVC service lines, the in-line wye fittings shall be slip joint ductile iron with an IPS sized branch for PVC schedule 40 service lines. Ductile iron fittings for connecting PVC service lines shall be deep bell, gasketed joint and air test rated. Gasket grooves shall be machined. Bell depths shall meet the minimum socket depth requirements of ASTM D3034 and ASTM F1336. Wall thickness shall meet the requirements of AWWA C153. Ductile iron wye fittings through 10-inches in diameter with IPS connections shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Ductile iron wye fittings for PVC lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein.

c) PVC Main with PVC Service
For PVC sewer mains to be joined with PVC service lines, PVC in-line wye fittings shall be provided. Typical Schedule 40 PVC fittings shall be provided at the cleanout wye and stack.

d) PVC Main with DIP Service
A ductile iron tee/wye shall be provided when the service line is required to be ductile iron due to a crossing or other obstruction. The fitting shall be specifically manufactured for ASTM 3034 PVC pipe such that a smooth flow way exists on the main line through the fitting. The branch shall be gasketed to receive the 4-inch DIP service line without additional fittings. The ductile iron tee/wye fitting shall be Protecto 401 lined.

3. Service Saddle Connections, Existing Sewer Mains

a) PVC service saddles shall be of the same material as the main, 45 degree deflection, and shall be solvent welded and fastened with single stainless steel bands. The saddle service branch shall be stubbed

slightly into the sewer main so that when installed, the saddle shall not slip or rotate.

b) For existing DIP main lines, ductile iron service saddles shall be used. The saddle assembly shall consist of a virgin SBR or NBR gasket compounded for sewer service, a ductile iron saddle casting, a 304 stainless steel adjustable strap for fastening the gasket and the saddle casting to the sewer main and a 304 stainless steel adjustable circle clamp for securing the service line into the rubber gasket. The saddle shall be furnished with adapters as required to properly receive the service pipe.

C. Installation

1. General Requirements

a) Sewer laterals shall not be located in easements when gravity service can be provided to the property frontage at the street.

b) Each separately owned structure requires a separate tap to a public sewer.

c) Four inch lines shall have a minimum slope of ¼ inch per foot and 6 inch lines shall have a minimum slope of 1/8 inch per foot.

d) Service connections to new mains shall include the use of wye (not tee) connections. Saddle taps onto new lines shall not be allowed.

e) Saddle taps into existing PVC mains shall be made at the 10 o'clock or 2 o'clock position of the main with the wye saddle angled 45-degrees towards the direction of flow in the main. Taps shall only be made by a mechanical circular cutting saw providing a smooth and uniform cut for the saddle installation.

f) Service connections shall be made using an approved sewer saddle when the existing sewer line is 8", 10", or 12" in diameter. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for the sewer saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

g) Service laterals to be maintained by the Town shall not be located beneath a driveway or curb, nor shall a clean-out be located in a sidewalk area without prior written approval from the Director of Water Resources.

704 Testing and Inspections

A. General

The Contractor shall furnish all materials, labor, and equipment to perform all testing. The Contractor may arrange to obtain water for testing purposes from the Town. The Contractor shall reimburse the Town for all water used for construction at current inside utility rates.

B. Sewer Main and Service Connection Testing

1. Visual Testing and Observation

   a) All materials used must be approved by the Town prior to installation. Rejected materials shall be immediately removed from the job site.

   b) Gravity sanitary sewer lines shall be clean and free from obstructions, and shall be visually inspected from every manhole. Lines which do not exhibit a true line and grade or which have structural defects shall be corrected. Sanitary sewer service connections shall be visually inspected prior to backfilling.

      The Town may re-inspect the line at any time prior to final acceptance if any damage or displacement is suspected to have occurred subsequent to the initial inspection

2. Air Testing

   a) Low-pressure air testing in accordance with ASTM F1417 shall be performed on all sewer mains before the laterals or stubs are installed on the line, and after the trench has been backfilled to finished grade. Plugs shall be installed at each manhole to seal off the test section. Prior to testing, the sewer line shall be clear of debris and flushed with water as necessary. The line will be pressurized with a single hose and monitored by a separate hose connection from the plug. Air then shall be slowly introduced into the sealed line until the internal air pressure reaches 5.0 psig. The air pressure shall then be allowed to stabilize for a minimum of 2 minutes. The line shall be "acceptable" if the pressure does not drop in the time prescribed for the test in the table below.

Nominal Pipe Diameter (in)												
Length of Test Section (ft)			8	12	15	16	18	21	24	30	36	42
	50		7:33	11:20	14:10	15:11	17:00	19:48	22:40	28:19	34:00	39:40
	100		7:33	11:20	14:10	15:11	17:00	19:48	22:47	35:37	51:17	69:48
	150		7:33	11:20	14:10	15:12	19:14	26:10	34:11	53:25	76:55	104:42
	200		7:33	11:24	17:48	20:16	25:39	34:54	45:35	71:13	102:36	139:36
	250		7:33	14:15	22:16	25:20	32:03	43:37	56:58	89:02	128:12	174:30
	300		7:35	17:06	26:43	30:23	38:28	52:21	68:22	106:48	153:54	209:25
	350		8:52	19:57	31:10	35:27	44:52	61:05	79:46	124:42	179:30	244:19
	400		10:07	22:48	35:37	40:31	51:17	69:48	91:10	142:30	205:06	279:13
	450		11:23	25:39	40:04	45:35	57:42	78:31	102:36	160:18	230:48	314:07
	500		12:39	28:30	44:31	50:39	64:06	87:15	114:00	178:06	256:24	349:02

b) If the section fails to meet these requirements, the source of leakage shall be repaired and the pipe section re-inspected

c) The Contractor shall furnish all plugs, compressors, hoses, gauges, and any other equipment necessary to conduct the low-pressure test.

3. Infiltration Tests

a) Portions of the sewer lines, which exhibit a higher ground water table during construction, shall be tested for infiltration. The portions of the line to be infiltration tested shall be determined by the Town.

b) The portion of the sewer line designated by the Town shall be tested for infiltration by installing a V-notch measuring weir or other suitable measuring device in the downstream end of the pipe to be tested. When a steady flow occurs over the weir, the rate of flow (infiltration) shall be measured. The rate thus measured shall not exceed 100 gallons per 24 hours per inch of sewer pipe diameter per mile of pipe. The Contractor shall furnish weirs and other equipment required for infiltration tests and the tests shall be performed in the presence of the Town.

c) Should the infiltration tests reveal leakage in excess of the allowable, the leaking joints shall be re-laid if necessary or other remedial construction shall be performed by and at the expense of the Contractor. The section of sewer thus repaired shall then be retested to determine compliance with the Specifications.

4. Deflection Testing for Flexible Pipe

a) The mandrel (go/no-go) deflection test shall be performed on each line prior to acceptance and no sooner than 30 days after installation. The pipeline shall be thoroughly clean and free of debris and/or sediment prior to testing. The Contractor shall supply the mandrel used for this performance test. The mandrel device shall be cylindrical in shape having 9 or 10 possible contact points with the pipe. The mandrel's length and diameter (ID of proving ring) shall be in accordance with the following tables, and shall be subject to the Town's approval.

b) For flexible pipes (such as PVC), the following shall apply:

Nominal Diameter (inches)	Pipe Class	Average Inside Pipe Diameter (inches)	5% Deflection Mandrel Diameter (inches)	Length of Mandrel (inches)	Minimum Fins Included with Mandrel
8	C900	7.98	7.58	10	9
8	SDR 35	7.891	7.496	10	9
10	C900	9.79	9.30	10	9
10	SDR 35	9.864	9.371	10	9
12	C900	11.65	11.07	10	9
12	SDR 35	11.737	11.150	10	9
15	SDR 35	14.374	13.655	10	9
16	C900	15.35	14.58	10	9
18	C900	17.20	16.34	24	9
24	C900	22.76	21.62	24	9

Note: Calculated 5% deflection allowance does not include additional manufacturing tolerances provided by pipe manufacturers. For the purposes of testing, 5% deflection shall be calculated from standard pipe inside diameter as published in ASTM D3034 and ASTM F679.

c) The mandrel shall be advanced through the pipeline to determine if bedding and embedment has been provided in compliance with ASTM D2321 to assure joint deflection of less than 5%. If the mandrel becomes obstructed for any reason while being pulled through the line with less than 100-lbs of force, the location of the defect shall be noted and the mandrel shall be removed from the pipeline. Under no circumstances shall heavy equipment be utilized to force the mandrel through the pipeline. Deflection testing may be done concurrently with sewer televising inspections, provided the mandrel is kept within visible range of the camera. The mandrel diameter shall have a tolerance of +/- 0.01 inch. Contact length shall not be less than 2 inches.

Any lines not meeting this test shall be corrected by the Contractor and the test repeated. The Town shall approve the mandrel. The Contractor shall furnish drawings of the mandrel with complete dimensions to the Town upon request.

5. Video Assessment and Cleaning

a) As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains prior to acceptance by the Town. A 3rd party CCTV Contractor shall televise the sewer main and all lateral connections installed from the upstream to downstream manhole with no reverse setups or cutaways. This shall be done at the Contractor's expense. Throughout shooting, the camera shall be panned and tilted for a complete view of the main. Lighting shall be adequate to view the entire sewer main and service connections from beginning to end. The video inspection shall be submitted to the Town on a CD/DVD and formatted with software compatible and readable by the Town. The Town shall not be responsible for purchasing additional software necessary to view the CD/DVD.

b) The camera shall be advanced at a uniform rate not to exceed 20 feet per minute that allows a full and thorough inspection of the new sewer main. The camera shall be a color, pan and tilt camera capable of producing a five hundred line resolution picture. Lighting for the camera shall be sufficient to yield a clear picture of the entire periphery of the pipe. The picture quality shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the sewer main shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

c) The Contractor shall clean the sewer mains ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2-hours of cleaning operations as witnessed by the Town. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system. No other work shall be performed on the Sewer lines after cleaning and prior to video inspection

d) The Town shall be present throughout the cleaning and televising of the sewer mains to verify that the video work complies with the Specifications. The camera operator shall stop, reverse, pan, and tilt the camera to view any area of interest during the inspection as directed from the Town.

e) It is recommended that all site grading and all utilities must be installed and complete prior to final inspection to ensure that damages to the sewer main do not occur. Damages found after final inspection would requiring re-inspection by the Town.

f) CCTV inspection date must be acknowledged and approved by the Water Resources Department prior to inspection. All structures must be physically labeled by the contractor with number shown on the video. Punch list items from the inspection must be submitted on the Town's approved 3rd Party CCTV Report form and all vides files uploaded to One Drive (flash drives and CD/DVDs are not acceptable).

g) The contractor may not perform CCTV inspections on any utilities that they have installed.

6. Marker Tape Testing

Testing of the marker tape shall be performed by the Contractor at the completion of the project to assure it is working properly and completely detectable. It is the Contractor's responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise non-locatable segments shall be replaced.

C. Manhole Testing

1. Vacuum Testing

a) All newly installed manholes shall pass a vacuum test in accordance with ASTM C 1244. The Contractor shall supply all equipment and materials necessary to vacuum test the manholes.

b) Vacuum Testing shall be completed prior to any specified coating and lining materials being installed.

c) The Town shall be present and witness all vacuum testing.

d) The following vacuum testing criteria shall apply for compliance with the testing procedure.

1) A vacuum of 10-inches of mercury shall be drawn with an approved vacuum testing unit.

2) The testing time shall not be measured until after the vacuum pump has been shut off.

3) The time required for the vacuum to drop from 10-inches to 9-inches of mercury shall meet or exceed the values listed in the following table.

Manhole Vacuum Testing Time

Depth	Manhole Diameter (inches)		
(feet)	48	60	72
Time (seconds)			
8	20	26	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

2. Holiday Testing of Lined Manholes

All manholes that require an epoxy coating shall undergo discontinuity testing. This shall be a high-voltage spark test conducted in accordance with NACE International Standard Practice 0188. All areas of the manhole coated shall be tested. The spark tester shall be set at a minimum of 100 volts per mil of coating thickness applied. The Contractor shall supply the spark tester and all testing equipment and labor needed to perform this test.

All holidays identified must be repaired. The epoxy coating must be abraded and cleaned prior to re-coating. All touch-up work shall be in accordance with the epoxy manufacturers guidelines.

705 Aerial Crossings

A. Design

Aerial crossings shall only be utilized in cases where buried crossings are not feasible due to stream crossings, compliance with riparian buffer standards, minimizing impacts to wetlands, preventing excessive depth of installation, or as otherwise directed by the Town of Apex. All aerial crossings shall have prior approval by the Water Resources Director and will only be considered if there are no practical alternatives available, cost shall not be considered justification for aerial crossings

In cases where aerial crossings are utilized to cross streams, the bottom of the pipe shall be installed above the 25-year flood elevation of the stream. Piers shall generally be located at a uniform spacing of 20-ft or 1 pier for every joint of pipe. Piers shall be provided in accordance with the standard details or as otherwise designed by a licensed NC Professional Engineer.

All pier footings shall be designed by a licensed NC Professional Engineer and the assumptions provided in the footing design shall be included on the plans. At a minimum, the footing design shall include: 1) the allowable soil bearing capacity, 2) design concrete compressive strength, 3) plan for reinforcing steel with sizing and location of bars, 4) force diagram including buoyant forces, stream velocity impacts 5) depth of installation to prevent frost heaving, 6) bedding design to prevent differential settlement and 7) factors of safety for unanticipated loads such as trees falling across the aerial crossing.

At a minimum all pier foundations shall be constructed on a base of 12-inches of washed stone. The soil conditions under the pier shall be evaluated by a licensed NC Geotechnical Engineer to determine if the allowable soil bearing capacity meets or exceeds the design assumptions included in the structural design. If the soil conditions fail to meet the specified bearing capacity requirements, a pile foundation shall be provided or the soils shall be undercut and replaced in conformance with the recommendations of the geotechnical engineer of record.

Piers installed in stream beds shall be avoided in lieu of spanned crossings. Spanned pipe crossings greater than 20-ft shall be provided in accordance with the pipe manufacturer's specifications and shall not exceed 40-ft for ductile iron pipe. Spanned pipe crossings shall be designed such that all flanges and exterior pipe connections are located above the 25-year flood elevation.

Spanned crossings greater than 40-ft without piers shall be provided in a steel encasement pipe and the entire crossing including piers, foundation, truss and/or beam supports and pipe thickness design shall be provided by a licensed NC Structural Engineer.

B. Pipe Materials

1. **Ductile iron pipe** for aerial crossings shall be interior lined with Protecto 401 at 40-mils regardless of pipe diameter from manhole to manhole. All joints for ductile iron pipe utilized in aerial crossings shall be restrained with a US Pipe Mech-Lok joint, American MJ Coupled joint, or other as approved by the pipe manufacturer, the Water Resources Department and the Engineer of Record. Ductile iron pipe utilized for spanned crossings greater than 20-ft without a pier shall typically be provided with flanged connections. All bolts and fasteners for flanged or bolt locking restraining systems shall be provided in stainless steel and installed in a manner to prevent seizing.

2. **PVC pipe** shall not be approved for aerial crossings.

3. **Steel pipe** provided for aerial crossings shall be fabricated with grade B steel that has minimum yield strength of 35 KSI in accordance with ASTM A139. Steel pipe for aerial crossings shall be provided with minimum wall thickness consistent with a pressure class of 200-psi or greater. Steel pipe for aerial sewer crossings shall be provided with 40-mils of interior ceramic coating, such as Ceramaline and provided with an exterior tape wrap approved by the manufacturer. All steel pipe joints shall be welded in conformance with manufacturers' specifications.

C. Installation

Aerial crossings are often utilized to span sensitive environmental areas and installation shall be consistent with plans to preserve the sensitive areas.

Joints of bolt lock or coupled restrained pipe shall be located within 2-ft of each pier as outlined by the detail drawings. Contractor shall ensure the length of pipe joints allows for this spacing.

Pipe shall be secured to each pier with 1/4-inch by 2-inch width steel straps fastened to 4; ½-inch stainless steel lugs anchored and adhered with epoxy to the concrete pier. The steel straps shall receive a weather resistant painted finish to prevent long term corrosion.

Precast piers may be submitted for approval provided the footing and foundation designs are completed by licensed structural and geotechnical engineers.

In cases where soil conditions cannot be sufficiently stabilized to provide an adequate foundation for concrete piers, a pile foundation designed by a licensed NC structural engineer and approved by the Town shall be provided.

Reinforcing steel for concrete piers shall be grade 40 and shall be constructed in conformance with the latest edition of the "Recommended Practice for Placing Reinforcing Bars" or other documentation as published by the Concrete Reinforcing Steel Institute.

In cases where rock exists at the foundation elevation, the footing shall be drilled and connected with dowels into the rock layer.

706 Repairs, Modifications, and Abandonment

A. Sewer Main Repairs

1. Vitrified Clay Pipe - replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

2. PVC Pipe - replace damaged section with PVC Pipe and install a Fernco coupling at each end encased in concrete.

3. ABS/PVC Truss Pipe - replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

4. Asbestos Cement Pipe - Replace damaged section with DIP and couplings encased in concrete.

B. Installation

1. All repairs to damaged sanitary sewer lines in paved areas shall be backfilled with ABC stone (crusher run) to a density of 95 percent Standard Proctor.

2. All repairs to damaged sanitary sewer lines shall be bedded with 6-inches of washed stone and compacted to a minimum of 95% Standard Proctor density before installing the new joint of ductile iron or PVC pipe.

C. Draining Sewer Mains

A detailed bypass pumping and emergency plan shall be required for any sewer line draining event.

All sanitary sewer mains and sewer force mains 20-inches and larger, active, inactive, or abandoned shall begin to be drained by tapping the bottom half of the pipe. A corporation stop or other valve shall be provided to control flow. All effluent shall be pumped to a downstream manhole (when available) or other containment tank utilizing continuous piping. The use of a sump pit on lines 20-inches and larger is not allowed.

In sensitive environmental areas and in other various scenarios the Water Resources Department may require lines less than 20-inches also be tapped in order to be drained.

D. Abandonment of Existing Sewer Mains

1. Existing sewer mains and casings located outside of road sections shall be removed, unless otherwise directed by the Town. All materials and labor shall be provided by the contractor.

2. Grout filling and abandoning in place may be allowed with prior approval from the Director of Water Resources.

SECTION 800
WASTEWATER PUMPING SYSTEMS AND FORCE MAINS

801 Pump Station General

A. Design Requirements

1. These Specifications apply to all pump stations and associated facilities that are to be owned, operated, and maintained by the Town of Apex. Designers of private pump stations and force mains and associated should look for guidance from the appropriate permitting agency (NCDEQ, NC Plumbing Code, etc.).

2. All aspects of the design of pump stations, and associated facilities shall, at a minimum, meet the requirements of the latest version of the NCDENR "Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains". Requirements presented in the Town of Apex Standard Specifications hereunder that are more restrictive or go above and beyond the requirements of the Minimum Design Criteria are required by the Town of Apex.

3. All aspects of the design of pump stations, and associated facilities shall be submitted for review and approval to the Town of Apex Water Resources Department. This review may be more extensive than the typical development site plan process. Materials necessary for the review and requiring approval include complete plans, Specifications, design reports, and specific equipment submittals for the specific pump station, as described hereunder.

4. Wastewater flow rates for the entire natural drainage basin must be accounted for as outlined in Specification 700, Wastewater Collection Systems. The receiving gravity sewer system that will accept flow from this pump station must also be evaluated to determine if additional flow can be accepted and if any improvements are required. All required improvements shall be incorporated as part of the pump station/force main project and shall be installed prior to the pump station becoming active.

5. Prior to approval of any pump station plan, a detailed economic analysis consisting of minimum 20-year present worth evaluation shall be submitted by the Engineer-of-Record comparing the extension of gravity sewer service with the construction of a pump station and force main alternative. Gravity sewer systems shall always be preferred over pump station and force main construction. The Town of Apex reserves its right to consider economic evaluations, service area configuration, operating costs and other external factors before approving pump station plan submittals in lieu of gravity sewer extensions. The estimated cost of the gravity alternative must be greater than 3.5 times the cost of the pumping station alternative in order for the Town to allow a pump station.

6. All equipment, except for the generator, included in this Specification shall be designed for a sound rating of 55 dB(A) or less at a distance of 21 feet from the operating equipment. The generator shall include a sound attenuating enclosure and hospital grade silencer. The generator shall have a sound rating of less than

71 dbA for generators rated below 150KW and less than 73 dba for generators, rated between 150KW and 250KW, at a distance of 21 feet from the operating equipment. Warning horns and sirens have no sound restrictions.

The pump station design shall incorporate ways to minimize the sound levels leaving the site property. Factors to consider include equipment layout, cumulative sound levels, and walls that reflect the sound. Equipment submittals that include the sound ratings for the major equipment to be installed at the pump station shall be supplied to and approved by the Water Resources Department prior to ordering the equipment.

The pump station shall not be approved for routine operation until sound testing has demonstrated that the noise levels are in accordance with the requirements of this section. All sound testing shall be performed by reputable personnel and testing equipment to assure accuracy. The Director reserves the right to require certified sound engineers in cases when the accuracy of the testing equipment is uncertain. The Director may also require sound testing to be redone prior to the end of the corrections period to further demonstrate that the pump station, including the generator, is performing as designed.

Generator testing and operation other than for urgent necessity in the interest of public health and safety shall be during the time periods of Monday through Friday between the hours of 9:00 a.m. and 4:00 p.m., not including holidays which are observed by the state.

7. All pump station facility design plans shall evaluate surge and water hammer, and incorporate sufficient surge suppression based on the range of flows, pressure and other variables included in the pump station design.

8. All pump station facility designs shall include emergency by-pass pumping capabilities and permit sufficient space to accommodate equipment staging.

9. All pumps shall perform a drawdown test to verify pump capacity flow rates. Town representatives shall be present during the test. Documentation of the test shall be provided to the Town for approval.

B. Warranty

1. All equipment, materials, and systems supplied under this Specification shall be provided with a warranty from the manufacturer to the Town that the subject equipment, materials, and systems shall be free of defects in workmanship and material, and shall operate as intended under the known conditions, for a minimum period of one year. The warranty shall be in printed form and made applicable to the Town (as Warrantee) at the time of acceptance for maintenance by the Town.

C. Submittals

1. Design Report

   a) A design report signed and sealed by a North Carolina Professional Engineer is required with the submittal of plans and Specifications for any facilities covered under this section that are proposed for construction. This design report shall contain, at a minimum, the following design criteria:

      1) Total dynamic head calculations for all applicable pumping situations.
      2) System curve and pump curve analysis used to determine pump selection and operating point.
      3) Pump station cycle and pump run times covering the high, low and average flows over the entire expected operating period of the pump station.
      4) Response time available in event of an emergency (time between the high water alarm and the first system overflow at average design flow and peak design flow).
      5) Pump station flotation/buoyancy calculations.
      6) Minimum velocity within the force main, including an analysis of the capabilities of the pumps to completely flush any depressed sections of the force main in a single pumping cycle.
      7) Maximum detention times within the pump station and force main covering the low flows over the entire expected operating period of the pump station.
      8) An evaluation of the capability of the receiving sewer to handle the peak flow discharge from the proposed facility in addition to the existing or planned peak flows currently handled by the receiving sewer or sewage facility.
      9) Airflow calculations and chemical dosing calculations for the odor control facilities (if applicable).
      10) Flow capacity and headloss calculations for the grinder unit.
      11) Calculations for the sizing of the backup power generator.
      12) If jockey pumps are being proposed calculations much show how the pump can meet all design criteria.
      13) Total number of lots or parcels serviced, off-site drainage area and zoning, average daily flow, and peak daily flow.

2. Project Review Submittals

   a) Project Review Submittals shall be submitted to the Town of Apex Water Resources Department for review and approval prior to application for a permit for the pump station or force main, and prior to entering into construction contracts or purchasing any equipment for the pump station or force main. Obtaining permits, entering into construction contracts, or purchasing any equipment in no way obligates the Town of Apex to accepting designs or

equipment that do not meet the specified standards or other requirements the Town may have.

b) The Project Review Submittals shall include, at a minimum, complete plans and Specifications, a design report as described above, and manufacturer's information on specific major equipment listed in this Specification section. The information submitted on equipment shall include, at a minimum, the name of the manufacturer and the specific model being supplied, fabrication and assembly drawings, detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished. It shall also include any system hydraulic schematics, electrical wiring diagrams, and control panel schematics. Additional detailed information that may be required for submittal for specific equipment is listed in the appropriate equipment section.

3. Pre-Approved Equal Submittals

a) Equipment and systems of equal quality and efficiency may be available from manufacturers and suppliers other than those listed in this Section. No attempt is made to preclude the furnishing of similar quality items by other manufacturers. The use of alternate equipment and products will be considered if it can be demonstrated that these items have equal or superior construction performance, operating and maintenance costs, offer a present worth cost equal to or less than the specified items, and do not adversely affect other system components.

b) Equipment and systems other than those listed in this Section must receive approval from the Director of Water Resources prior to application for a permit for the pump station or force main, and prior to entering into construction contracts or purchasing any equipment or systems for the pump station or force main. Purchasing equipment in no way obligates the Town of Apex to accepting equipment that does not meet the specified standards or other requirements the Town may have.

c) Pre-Approved Equal packages shall include the following information as a minimum:

1) Current catalog data sheets and complete technical data to support Specification compliance.
2) A point-by-point list clearly stating all differences between the named item and the proposed alternate and a separate list clearly stating all exceptions to the Specifications. If no exceptions are listed, then no exceptions to the Specifications will be allowed.
3) Installation list with name, address and phone number of contact person for each of at least five (5) installations where the proposed equipment has been in similar service and satisfactory operation for

at least two (2) years. The date of placing equipment in service at each listed installation shall be provided.

4) Three (3) copies of Pre-Approved Equal information shall be submitted.

d) Equipment that meets the Pre-Approved Equal submittal requirements, the technical Specification requirements, and all other requirements of the Town of Apex, will be approved by the Director of Water Resources via letter within 14 calendar days of receipt of a complete package. Approval of Equal equipment or systems in no way eliminates the requirement for complete submittals at a later date.

4. Testing Results Submittals

a) The results of all testing shall be submitted to the Town of Apex Water Resources Department for review prior to continuing progress on the particular equipment. If shop testing is required, results shall be submitted prior to delivery of the equipment. If installation verification is required, results shall be submitted prior to start-up and testing of the equipment. If final start-up tests are required, results shall be submitted prior to final acceptance of the equipment.

b) Three printed copies of all test results are required to be submitted for review.

c) A final, compiled summary of all testing done on all equipment shall be provided to the Town of Apex upon completion of the project prior to project closeout and final acceptance. This final, compiled summary shall consist of a single bound printed copy, and an electronic copy (CD).

5. Operation and Maintenance Manuals (O&M)

a) Operation and Maintenance (O&M) manuals are required for all equipment and systems furnished under this Specification section. **Three copies shall be supplied to the Town in printed format prior to startup of the subject equipment or systems.** The O&M manuals shall contain all of the necessary information for proper operation and maintenance of the subject equipment and systems. At a minimum, the O&M manuals shall contain the following:

1) Final approved shop drawings.
2) Design data including certified pump curves and system curves.
3) Wiring diagrams and control schematics.
4) Detailed inventory of installed equipment, including its functional description, and manufacturer name, address, and phone number (and the same for a local representative of the manufacturer).
5) Operating instructions.
6) Troubleshooting techniques.

7) Maintenance schedules.
8) Assembly and disassembly instructions.
9) Instructions for start-up and shutdown, as well as calibration and adjustment.
10) Annotated hard copy and downloadable electronic copy of application program for all field programmable equipment (eg PLCs, operator interfaces, etc.)

b) A final, compiled Operation and Maintenance (O&M) manual covering all equipment and systems supplied, shall be provided to the Town of Apex upon completion of the project prior to project closeout and final acceptance. This final, compiled summary shall consist of a single bound printed copy, and an electronic copy (CD).
c) Any spare parts listed in the O&M manuals and/or recommended by the manufacturer shall be provided to the Town with the O&M Manual submittal.

802 Pump Station Site and Structures

A. General

1. Pump stations shall be designed in accordance with these standard specifications, the Town's Standard Details, and NCDEQ's manual for the Minimum Design Criteria for the Permitting of Pump Stations and Force Mains.

2. Pump stations shall be located on a parcel or an easement that is dedicated to the Town of Apex. The site shall be directly connected to a dedicated public right-of-way or have a dedicated access easement to a public right-of-way.

3. The Town requires sewage grinders, on-site backup power, and odor control facilities at all pump stations. Sizing of these items will be based on expected flow volumes and characteristics.

4. All stations shall have a minimum of 2 pumps of equal capacity. The pumps shall be solids handling, submersible, centrifugal pumps each capable of pumping flows equal to the expected peak hourly flow. The allowable peak flow can be found in Section 0700. The Director of Water Resources may require that higher peaking factors be used. The Director of Water Resources may require wet well/dry well pumping systems when peak flows exceed 1-MGD. Where 3 or more pumps are required, they should be of such capacity that with the largest unit out of service, the remaining units shall have capacity to handle the peak hourly flows. Pumps and force mains shall be sized to provide a minimum velocity in the force main of 2.5 fps and a maximum velocity of 10 fps.

5. Pump stations shall remain fully functional, operational, accessible and free from physical damage during a 100-year flood.

B. Site Work

1. The site shall be graded to drain and direct stormwater runoff away from the pump station, and to remove storm water runoff from the site in a non-erosive manner. Drainage swales shall be incorporated to direct drainage away from the site, if necessary.

2. The site shall be stabilized by a minimum of 12" crushed stone over 98% compacted subgrade, low maintenance vegetative ground cover or other suitable materials. Visual screening and landscaping shall be provided in accordance with the approved site plan.

3. The site shall be secured by an 8-ft high vinyl coated chain link fence. It shall have 3-wire vinyl coated barb arms, set at an outward facing 45 degree angle and located at the top of each post. Each wire to be 3 strand barb wire class III galvanized or aluminized. The outer barb wire shall hold a load of 250-lbs. The 8-ft height does not include the barb arms. The vinyl coating shall be black and provided with UV resistant vinyl. Fencing shall be provided around the entire perimeter of the pump station property maintaining an offset of 10-12 feet from the property boundary. All fence posts shall also be vinyl coated over the galvanized steel in black color to match fencing and privacy screening. Manual slide gates for smaller pump stations shall permit 180-degree opening and be provided in minimum width of 14-ft. Gates at larger pump stations receiving chemical deliveries shall be a minimum of 16-ft wide to accommodate tractor trailer accessibility and be provided with electrically operated slide gates. All gate posts and corner posts shall be provided with minimum 4-inch diameter fence posts. The fence shall be screened with a row of evergreen shrubs, in accordance with the Town's UDO and Planning requirements, that are at least 5' in height at the time of planting. The fence gates shall be provided with black vinyl coated privacy slats rated for a minimum life span of 12-years. If site conditions do not allow for evergreen shrubs, then privacy slats shall be provided across the entire surface area of the fence including gates.

4. The pump station site shall permit the loading and removal of all equipment (pumps, grinders, generators, etc.) from the pump station site with an appropriately sized truck and/or crane.

5. The site shall feature adequate turn around areas for a WB-40 service vehicle and provide a minimum 16 foot wide all-weather access road to the site with grades not to exceed 10%. If chemical feed systems are included, additional turning radius may be required. The access road shall consist of a standard concrete curb tie and apron through the right-of-way and transition to an asphalt-concrete section with an 8-inch stone base and 3-inch surface course, or 12" of crushed stone over minimum 98% compacted subgrade. Shoulders and side ditches should be included, as applicable.

6. An **LED** light equivalent to a high pressure sodium vapor light with a minimum 600 watt capacity in compliance with Town of Apex standards, is required. The light shall be mounted on a suitable utility that retracts or pivots for bulb maintenance from ground level. The light shall be at a height of 30 feet and shall be controlled by an on/off switch mounted on the pole. All area lighting shall be provided in a downward projecting fixture, such as shoe box type light or approved equal. Open globe lighting shall be prohibited on all pump station sites.

7. Pump stations shall have a metered potable water supply from the Town of Apex public water distribution system at minimum sizing of 1-inch service, but provided with sufficient volume and pressure for operations including wash downs, etc. For larger stations a 2-inch service shall be provided to accommodate larger wash down and service needs. The supply shall have an approved lead free reduced pressure principle, RPA, backflow prevention assembly. A minimum of one (1) freeze proof yard hydrant is required within the fenced area. Emergency shower and eye washing basin shall be provided in pump stations with chemical odor control facilities. Separate reduced pressure principle assemblies, RPA, backflow preventers shall be required as necessary to protect eye wash and/or emergency shower stations from potential chemical contamination within the pump station site. As required by ANSI Z358.1, the shower and eye wash stations shall be provided with a tepid water system and be able to operate simultaneously. Pressure reducing valve shall be required for any static pressure over 80 PSI.

8. A grounding electrode system shall be provided for all pump station site wiring systems and shall be connected to the fence, generator, and electrical service.

C. Structures

1. <u>General</u>

   a) The submersible pump station structures shall consist, at a minimum, of a grinder manhole, a wet well, and a valve vault. Large, integrated structures are permissible, however, there shall be walls separating the portions of the structure listed above. Electric motor operated grinders will be required at all stations. Pump station structures other than the wet well shall be provided with a means to remove accumulated water and wastewater from the structure.

   b) Any portion of a pump station structure that is open and would allow floodwater entry into the wastewater system shall be built with a top elevation of 2 feet above the 100 year flood elevation. All structures not meeting the elevation requirement that could allow entry of floodwater into the wastewater system shall be sealed watertight with a vent elevated a minimum of 2 feet above the 100 year flood elevation.

c) All pump station structures shall be designed to withstand hydrostatic forces that they will be subjected to, including uplift and shall be equipped with buoyancy collars.

d) Refer to standard detail for stone base requirements under all structures.

e) Fall protection grating shall be installed at all access hatches. Additional anchor posts shall be installed according to the Standard Detail.

2. Wet Well

a) The wet well shall have a minimum inside dimension of 6 feet, and shall be large enough to easily accommodate the removal of each pump and a basket strainer. The wet well shall be designed to have an operating volume sufficient to provide pump operating cycles to match the manufacturer's recommendations. The pump operating cycles must be between two and eight times per hour at design daily flow (without being excessively deep. All wet wells must be concentric.

b) The wet well shall be constructed of precast concrete manhole sections or cast-in-place concrete. Extended bases or another foundation shall be used to provide adequate bearing surface and flotation protection, if needed. All concrete shall have a minimum 28 day compressive strength of 4000 psi. The Director of Water Resources may require a higher strength concrete.

c) Precast concrete manhole wet wells shall conform to ASTM C-478. Manhole section joints shall be of a durable mastic sealing material and be watertight in accordance with ASTM C-443. The exterior of manhole wet wells shall have a factory applied bitumastic or asphaltic coating. The exterior of wetwell joints shall be overlapped by an approved material such as Conwrap, Conseal, etc. The interior side of the joints shall be plastered smooth with portland cement grout.

d) Cast-in-place wet wells shall be properly designed by a NCPE and include appropriate structural support, waterproofing, exterior coating, structure covers, access hatches, etc.

e) At a minimum, wet wells shall have a vent made from ductile iron with flanged joint pipe fittings. An insect screen shall be included at the exposed end of the vent pipe. The screen shall be bronze or aluminum insect screening. Forced air venting is also allowed and will be required on individual pump stations in conjunction with odor control measures, depending on circumstances.

f) Wet wells and wet well piping shall be coated with at least 80-mils of an approved monolithic epoxy coating system consisting of a 100% solids, solvent-free, two-component epoxy resin for up to 100 mils of coating with a

manufacturer approved set time of 6-hours or less. The epoxy coating system shall be Sherwin Williams Sher-Flex, Raven Lining Systems, or approved equal and installed in no more than 2 applications with no runs and no holidays. High voltage holiday testing shall be utilized to verify there are no voids in the coating. The joints of pre-cast structures shall receive three (3) coats of mortar so as to achieve a smooth surface at each joint. Epoxy coatings shall only be applied to adequately cured concrete structures that have been sufficiently washed and prepared for epoxy coating installation. Properly applied coating shall provide a smooth finish at 80-mils or greater and fill all pores in concrete substrate.

g) Care will be taken to ensure no epoxy coating is applied to the pump coupling face, the guide rails, or any other part that needs to allow movement or replacement on a regular basis.

h) Cover slabs for wet well and valve vaults shall be reinforced concrete with integral cast in place access hatch covers. Cover slabs shall be reinforced as per ACI Code and specially reinforced around openings. Access covers shall be double leaf or single leaf (as required) aluminum diamond pattern floor hatch of 1/4-inch (minimum) thickness capable of withstanding 150 psf without permanent damage. Each leaf shall open 90 degrees and be attached to the frame by steel hinges. The door shall have a lock in the open position and vinyl grip handle to release lock for closing.

i) Each we well shall be equipped with a removable extension ladder as specified to enable access. The Town shall designate the location during the review process.

j) Pre-cast structures shall have a Sherwin Williams Sher-Flex, Raven Lining Systems, or equivalent applied to the outside of all tongue and groove joints. Prior to backfilling the wet well structure, the entire surface shall receive 1 coat. The material used for exterior coating shall meet the requirements of Corps of Engineers Specification C-200. The exterior coating shall be applied as to achieve a total dry film thickness of 80-125 mils. The exterior surface shall be clean and dry prior to application of the coating.

k) All bolted connections, including pipe flanges, inside the wet well shall be made using stainless steel bolts, nuts, and washers.

l) An aluminum handrail shall be provided around the wet well opening of all submersible pumping stations. The handrail shall be closed on three sides, with the fourth side closed by a latching chain. The handrail shall be permanently attached to the concrete cover slab. The chained side of handrail shall face the chain link fence gates for access and pump maintenance. A minimum horizontal clearance of 10 feet between the chains and handrail is required. Hand rails shall be grounded to the primary ground on-site.

m) A fall-through prevention system shall be provided with the wet well hatch doors. The system shall be a grate consisting of two leafs made of 6061-T6 aluminum hinged on the same side of the hatch. The grate shall be designed to withstand a minimum pedestrian load of 300 lbs. per square foot. The grate openings shall be 4" x 6" to allow both visual inspection and limited accessibility for maintenance purposes when the grate is closed. The leafs of the grate will pivot on aluminum hinge devices with 316 SS hardware that permit them to rotate upward 90 degrees and automatically lock in place. Aluminum pullrods will be attached to the grate's leafs so the operator is positioned with the grate between him and the hatch's opening whenever he raises a leaf. Each grate leaf will have a rod made from 316 SS that automatically engages to secure the leaf in its open position, and can be lifted upward to permit the grate leaf to close. The hatch cover will not be able to shut until the grate is closed, thereby insuring the grate is in position when the next operator opens the hatch cover. The grate shall have an OSHA safety yellow finish to increase visual awareness of the safety hazard.

3. Valve/Meter Vaults

a) The valve/meter vault shall, at a minimum, consist of a precast concrete manhole base section at least 6 feet in diameter, or a cast in place concrete, custom built section, or a precast concrete rectangular structure at least 6 feet square. The valve/meter vault shall be complete with a drain that goes to the wet well or where a gravity drain cannot be included, a sump with a minimum ½ hp mercury float switch activated sump pump discharging to the wet well. The vault shall include an access ladder attached to the vault wall, and access cover cast in the top slab with an extendable/retractable grab bar. The drain pipe between the valve vault and the wet well shall have a back water valve at the wet well end. The access cover for the valve vault shall be a square lockable hatch of 1/4 inch aluminum diamond pattern plate with steel hinges on an aluminum frame cast in place in the cover slab. All access covers shall be centered over equipment to accommodate service and removal and includes a removable metal grate style fall protection guards. Stainless steel or galvanized pipe stands shall be used to support valves and other appurtenances requiring support.

4. Manholes

a) Any manholes installed on the pump station site need to meet the standards described in Section 0700 of the Town of Apex Standard Specifications. All manholes installed on the pump station site shall receive an interior coating of an approved epoxy resin, as previously specified for the pump station wet well. All manholes located within the 100 year flood elevation shall receive an exterior coating as specified in Section 0700.

5. Buildings

   a) Building systems to house chemical feed facilities shall be adequate to provide sufficient storage, clearance, and full containment of chemicals in the event of a chemical tank or other failure. A removable roof or roof sections shall be required to allow sufficient access to all equipment and tanks within the building. All supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be designed and sealed by a NCPE. Chemical feed delivery lines will be chemical resistant and of a flexible material routed through oversized schedule 80 conduit

   b) On a case by case basis, a building may be required to house all electrical and control equipment. This building shall be of precast, prefabricated, or built in place construction.

   c) All buildings located on a pump station site shall have the first floor elevation a minimum of 2 feet above the 100 year flood elevation.

   d) Buildings shall be heated to avoid the freezing of chemicals.

D. Piping and Valves

1. Piping: Suction and discharge piping shall be Class 50 ductile iron flanged pipe in accordance with AWWA C 115. Discharge piping and valves shall produce a minimum head loss while maintaining a minimum velocity of 3 feet per second. All exposed piping shall have adequately sized and located restraint.

2. Pump piping: The discharge connection elbow shall be a straight through fitting with no flap valve and shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. The entire weight of the pump shall bear upon the guides and base support with no part of the pump bearing directly on the floor of the wetwell. A stainless steel chain shall be provided for lifting each pump from the wet well. All hardware used shall be 316 stainless steel.

3. All piping, couplings, fittings, valves, etc. shall be Class 125 for flanges meeting ANSI B16.1, unless Class 250 flanges are required for high head installations.

4. Check Valve: An external weight spring loaded or air-cushioned or hydraulic loop check valve and a plug valve shall be provided for the discharge pipe of each pump. A 1/4 turn plug valve shall be provided on the discharge pipe from the valve vault (the beginning of the force main). Check valves shall be ductile iron bodied, fully bronze mounted with bronze clapper disc and bronze seat ring, and shall have a spring loaded lever arm capable of being mounted on either side of the valve.

Check valves and plug valves shall be mounted in the horizontal position with a minimum of 3 feet of separation between each valve body and the outside walls. All valves shall be centered on the vault door for maintenance access and valve removal.

5. Plug Valve: Plug valves shall be 1/4 turn, eccentric action and resilient plug facing with heavy duty stainless steel bearings and welded-in corrosion resistant nickel seat. Pump station plug valves shall be "full-port" cross-sectional area perpendicular to the flow of at least 100% of the adjoining pipe.

   Plug valves and check valves on the discharge side of each pump shall be located in a valve vault separate from and adjacent to the wet well. A Victaulic type coupling shall be installed on each discharge main between the wet well and the valve vault. An isolation plug valve shall be installed downstream approximately 50-feet from the valve/meter vault in order to isolate the force main from the vault and equipment. Valves shall be rated for a minimum of 175 psi working pressure and be able to pass a 3-inch solid

6. Pressure gauge: A +/- 2% accuracy pressure gauge with a 3 inch or larger liquid filled dial, stainless steel case, and graduated to 150% of force main static pressure shall be provided on each discharge pipe. The gauge shall be installed between the check and plug valves. Isolation seals and cut-off ball valve shall be provided between the gauge and force main. The gauge shall be oriented so that it is easily visible and legible from the valve vault hatch opening. The gauge shall also be capable of delivering an electronic remote signal compatible with SCADA.

7. Air Release Valve: Each pump shall have an air release valve, installed on the discharge prior to combining with other pumps and leaving the valve vault. Air release valves shall be installed in manholes outside of the valve vault.

   There shall be one additional air release valve installed in a manhole on the force main, prior to the main leaving the pump station site.

8. Surge Valve: There shall be one surge valve installed within the valve vault.

9. Flow Meter: A full size electromagnetic flow meter shall be installed in a manhole or vault on the discharge side of the valve vault.

10. Trash Basket:

    A. Each pump station shall have one aluminum trash basket with guide rails with the following requirements:
       1. Basket shall have bar screen on the front and bottom with a minimum 1-1/4 inch to maximum 2 inch clear opening between 1/4-inch thick bars. The sides of the basket may be solid.
       2. Basket shall have a minimum of four solid aluminum wheels with stainless steel axles for easy removal from wetwell on aluminum guide rail system.

Guide rail system shall not be provided with ladder rungs. Provide basket stop bar for installation in field to insure proper location of basket.

3. Minimum dimensions: 2 inches wider than OD of influent pipe, 18 inches deep, and 18 inches high. Influent pipe must be able to pass through guide rails to influent face of basket.

11. Anchor Bolts.

a) Anchor bolts and nuts shall be furnished as required for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall be at least 3/4 inch in diameter. Anchor bolts and associated hardware shall be 316 stainless steel.

b) Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2.5 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 0.5 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each anchor bolt.

c) Anchor bolts shall be long enough to accommodate 1.5 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete. Bolts shall have a "J" bend anchoring them into the concrete.

d) Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

E. Electrical - General

1. All electrical systems associated with any of the items covered under this section shall meet all applicable electrical standards and code requirements, including, but not limited to: ANSI, ASTM, NEMA, IEEE, DEMA, EEI, HEI, ISO, NFPA, SAE, NEC, UL508, as well as any other federal, state, or local codes.

2. Electrical service to all pump stations shall be appropriately sized three phase power, 240 VAC with automatic transfer switches to automatically starting on-site emergency generators. The electrical power entrance shall be through a meter base, followed by a NEMA 3R heavy duty, single throw, and fusible safety switch. This shall be followed by a heavy duty automatic transfer switch that transfers between the utility power and the on-site generator. This shall be followed by a NEMA 3R heavy duty, double throw, three pole safety switch which feeds the control panel from one side and heavy duty, circuit breaking 4 wire, 4 pole male receptacle assembly as manufactured by Crouse-Hinds or other approved equal

from the other side. There shall be a NEMA 3R heavy duty single throw fusible safety switch between the generator and the automatic transfer switch.

3. Electrical equipment inside the wet well shall meet the requirements for Class I, Division I, and Group C/D service.

4. All of these electrical components shall be suitably sized to be capable of service with all electrically powered equipment running.

5. All electrical components, including panels, shall be sealed off from the wet well in accordance with the N.C. Electrical Code requirements for electrical service to class 1 division 1.

6. The use of rigid conduits is required. Generally, PVC shall be used below ground and PVC coated galvanized steel shall be used above ground. Conduits that lead to a control panel shall be air gapped a minimum of 3-feet from the panel or seal-offs shall be provided.

7. Pump station electrical and control equipment shall be located in a building as described above, or under a weatherhood. An aluminum weatherhood with a clear height of 7 feet, an overhang of at least 4 feet and a thickness of 3/16 inch shall be provided for control equipment exposed to the weather. The back panel and side panel shall also be 3/16 inch thick aluminum. The support structure for the weatherhood shall be made from structural steel members assembled to provide individual, direct support to the control equipment panel, transfer switch, safety switches, meter base and the weatherhood. The steel frame shall be painted with a two component, high build epoxy polyamide paint system designed for severe service. All weatherhoods shall be provided with a light and GFI protected 120V outlet.

8. All electrical equipment, including non-submersible motors, electrical panels, control panels, alarm/telemetry systems, backup generators, etc., shall be located a minimum of 2 feet above the 100 year flood elevation. Weatherhoods shall be installed to eliminate runoff to the front side. All electrical enclosures shall have hinged doors/covers. The control panel shall include a concrete pad, minimum 8’ x 4’ x 6” thick.

9. An intermediate terminating explosion proof junction box is to be supplied and installed mid-way from the wet well and the pump control panel. This box shall be NEMA type 4X suitably sized to house all pump power and control wiring. Rigid metal conduit shall be utilized with the necessary seal-off fittings. Terminal strips shall be provided to properly split the power termination to facilitate pump removal from the junction box and not the pump control panel.

   Exposed outlet boxes for outdoor and indoor wet process areas used for lighting fixtures, switches, and receptacles shall be aluminum provided with rubber

neoprene gasketed covers of similar metal. Junction and pull boxes shall be NEMA 4X construction and of ample size to house the required devices. Boxes shall be provided with hasps.

The minimum size of boxes shall be according to the NEC. No box shall be filled to more than 40% of capacity.

Where control wires must be interconnected in a junction box, terminal strips consisting of an adequate number of screw terminals shall be installed. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected. Approximately 20 % of the terminals provided shall consist of spare terminals. Terminals shall be lettered and/or numbered to conform with the wiring diagram.

803 Pump Station Equipment

A. Pumps

1. General

a) Pumps, motors, and major accessories shall be supplied by a single manufacturer and must be Fairbanks Morse, ABS, Hydr-o-matic, or HOMA.

b) Each pumping unit shall be complete with a close-coupled, submersible electric motor, and all other appurtenances specified, or otherwise required for proper operation.

c) The equipment provided under this section shall be suitable for the service conditions and shall be capable of meeting all operating requirements of the pumping system.

d) Each pumping unit including motor and all integral controls shall be rated and labeled for use in a Class 1, Division 1, Group C/D area as defined by the National Electric Code.

e) Each item of equipment and each part shipped separately shall be identified with indelible markings for the intended service. Tag numbers shall be clearly marked on all shipping labels and on the outside of all containers.

f) Abbreviations. Reference to standards and organizations herein shall be as indicated by the following designations.

1)AFBMA	Antifriction Bearing Manufacturers Association
2)AGMA	American Gear Manufacturers Association
3)AISI	American Iron and Steel Institute
4)ANSI	American National Standards Institute

5)ASME American Society of Mechanical Engineers
6)ASTM American Society of Testing and Materials
7)NPT National Pipe Thread
8)SAE Society of Automotive Engineers

2. Submittals

a) Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section. The data and specifications for each unit shall include, but not be limited to, the following:

1)Pumps
1) Name of Manufacturer
2) Type and model
3) Rotating speed
4) Direction of rotation
5) Size of suction elbow inlet
6) Size of discharge elbow outlet or nozzle
7) Net weight (mass) of pump and motor only
8) Complete performance curves showing capacity versus head, bhp (brake kW), NPSH required, and efficiency
9) Data on shop painting

2)Motors
1) Name of manufacturer
2) Type and model
3) Type of bearings and method of lubrication
4) Rated size of motor, hp (kW), and service factor
5) Insulation class and temperature rise
6) Full load rotative speed
7) Net weight
8) Efficiency at full load and rated pump condition
9) Full load current
10) Locked rotor current

b) Operation and Maintenance Manuals shall include, at a minimum, the following information:

1) Equipment function, normal operating characteristics, and limiting conditions.

2) Assembly, installation, alignment, adjustment, and checking instructions.

3) Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

4) Lubrication and maintenance instructions.

5) Guide to troubleshooting.

6) Parts lists and predicted life of parts subject to wear.

7) Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

8) Test data and performance curves.

3. Quality Assurance

a) Performance and Balance Requirements

1) All specified conditions shall be at rated speed unless otherwise indicated.

2) Overall (wire-to-water) efficiency for constant speed pumps shall include losses in the pump and motor. Overall (wire-to-water) efficiency for variable speed pumps shall include losses in the pump, motor, adjustable frequency drive, and any transformers supplied as part of the adjustable frequency drive equipment.

3) The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

4) Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.01 inch or 1 mil per inch of casing wearing ring diameter, whichever is greater.

5) When required, pumping units shall be designed so that maximum reverse rotation due to reverse flow at the head as required will not cause damage to any component. Pump supplier shall coordinate this provision with the motor supplier.

6) All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operation speeds is avoided. In any case, the unfiltered vibration velocity, as measured at

any point on the machine including top of motor, shall not exceed the maximum velocity as indicated for vertical, end suction, solids handling pumps. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

4. Materials

   a) Stator housing, oil chamber housing, impeller casing, and impeller shall be cast iron, ASTM A48.

   b) Casing wearing ring shall be bronze, ASTM B62, or rubber, or martensitic stainless steel, Brinell 300+.

   c) Bottom wearing plate shall be cast iron, ASTM A48 with spiral grooves.

   d) Impeller wearing plate shall be martensitic stainless steel, Brinell 200-250.

   e) Shaft shall be alloy steel, hard chrome plated, or martensitic stainless steel, AISI type 416.

   f) Mechanical seals shall be 2 tandem single type, oil lubricated with silicon or tungsten carbide seal rings at all points, except the upper rotating seal, which shall be carbon.

   g) Discharge base shall be cast iron or fabricated steel.

   h) Guiderails shall be stainless steel pipe, ASTM A312, Schedule 40S.

   i) Upper guiderail bracket, cable hooks, and chain hooks shall be AISI type 304 stainless steel.

   j) Pedestal base shall be cast iron or fabricated steel.

5. Pumps

   a) Pumps shall be submersible, non-clog centrifugal sewage pumps capable of passing a 3 inch sphere. Pumps shall be capable of handling raw, unscreened sewage. Major pump components shall be of gray cast iron devoid of burrs, pits or other irregularities.

   b) The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. The discharge nozzle shall be flanged, with dimensions and drilling conforming to ANSI B16.1, Class 125. The discharge nozzle shall be flanged and sufficiently rigid to support the pumping unit under all operating conditions.

c) The impeller shall be a semi-open and enclosed recessed one-piece casting with not more than two nonclog passages with the impeller completely out of the flow path. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.

d) For pumping units 20 hp and larger, renewable wearing rings shall be provided in the casing and on the impeller. The rings shall be positively locked in place. For pumping units less than 20 hp a renewable wearing ring or axially adjustable wearing plate shall be provided in the casing. Casing wearing ring shall be securely fastened to the impeller casing front cover to provide either an axial or radial running clearance. Axially adjustable wearing plate shall be arranged to permit adjustment of the axial running clearance between the impeller and plate. The wearing plate shall have an outward spiraling groove designed to force stringy solids outward and away from the impeller.

e) The oil chamber shall contain a drain plug and a vent plug. Food grade oil shall be used.

f) Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement. Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended period while pumping under load.

g) All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is needed. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

6. <u>Pump Motors</u>

a) The pump motors shall be sealed submersible type, and shall be appropriately sized three phase power, 60 Hertz motors with a maximum speed of 1800 RPM. The motors shall meet the U.S. requirements of Class I, Division I, and

Group D for hazardous locations, and shall be sized to non-overloading throughout the entire operating range of the pump.

b) A heat sensor thermostat shall be attached to and embedded in the winding and be connected in series with the motor starter contactor coil to stop motor if temperature of winding is more than 220 degrees F. Thermostat shall reset automatically when motor cools to safe operating temperature. The common pump motor shaft shall be of 416 stainless steel. (See 4E)

c) The motor shall be protected by mechanical seal system as described above. A double electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control panel. This signal shall not stop the motor but shall act as a warning only.

d) Power cables to pumps shall be AWG (min) hypalon jacketed type SPC cable a minimum of fifty (50) feet in length.

e) Motors shall be provided by the pump manufacturer and shall be air-filled, totally submersible. Motor nameplate rating shall exceed the maximum power required by the pump in the operating head range. Each motor shall have a voltage, frequency, and phase rating as required and shall have a service factor of 1.15. The stator housing shall be an air-filled, watertight casing. A cooling jacket shall encase the motor housing for each pump where needed to maintain adequate cooling. Cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class F, 180 degrees Celcius. Each motor shall be NEMA Design B for continuous duty at 40 degrees Celcius ambient temperature, and designed for at least 10 starts per hour.

f) Each motor housing shall be provided with a moisture detection system provided by the motor manufacturer and per the manufacturer's requirements, complete with all sensors, control power transformer, intrinsically safe control modules, and relays. The moisture detection system shall be rated for a 120V AC supply. The moisture detection system shall provide two normally open dry output contacts rated 5 amps at 120 volts AC. The contacts shall close when moisture is detected in the motor housing and an alarm relay energized. The pump shall not be shut down. All moisture detection system components shall be furnished by the pump supplier and shall be shipped loose for installation into the motor controller enclosure, or if required to be mounted separately all components shall be mounted in a NEMA 4 stainless steel enclosure.

g) The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated AFBMA L10 Live Rating of 40,000 hours when operating at maximum operating head. Maximum shaft

runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.

h) Thrust bearings shall be protected by bearing temperature switches. The switches shall be normally closed automatic reset type rated 5 amps at 120V AC.

i) Each motor shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions, without exceeding the temperature rise limits for the motor insulation system.

j) Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements.

k) All cables shall be of sufficient length to terminate in a junction box outside the wetwell as indicated on the drawings, with 10 feet of slack that shall be coiled on a cable hook at the top of the wetwell. Each cable shall be supported by AISI Series 300 corrosion-resistant PVC Style woven Kellem Grips type woven grips to prevent damage to the cable insulation. Mounting of cable supports in the wetwell shall be coordinated to prevent damage to the cable.

l) The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

m) Motors with an adjustable frequency type speed controller shall be derated to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by adjustable frequency drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

n) Adjustable Speed Drives: Adjustable frequency drives shall be provided as specified by the Director of Water Resources or if the projected flow is .5MGD or higher.

o) Station pumps between 15-30 hp shall have a 30 hp rated RVSS. Stations with pumps greater than 30 hp shall utilize variable frequency drives with appropriately sized RVSS.

7. Appurtenances

a) The lift out systems shall consist of a straight elbow that bolts to the bottom of the basin, a combination disconnect assembly with a seal flange that mounts to the pump, rail support guides that fasten to the wall of the basin and guide and support brackets that mount to the pump. The guide rails shall be type 316 stainless steel, 2 inch minimum diameter, schedule 40

b) Guiderail Mounted Base. A discharge base and discharge elbow shall be furnished by the pump manufacturer. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wetwell. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125. The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the wetwell and replaced without the need for operating personnel to enter the wetwell.

c) Sliding Bracket. Each guiderail mounted pumping unit shall be provided with an integral, self-aligning guiderail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions. The sliding bracket shall be non-sparking.

d) Guiderails. Each guide rail mounted pumping unit shall be equipped with one or more guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to just below the bottom of the access hatch. An upper guiderail bracket shall be provided at the pump access opening. Guiderails shall be made of stainless steel.

e) Lifting Chain. Each guide rail mounted pumping unit shall be provided with a chain suitable for removing and installing. The chain shall be stainless steel with 4x6 lifting eyes at 10ft intervals starting at the top. A suitable chain hook shall be provided at the top of the wetwell. A stainless steel cable is not an acceptable alternative to a lifting chain.

f) Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and

accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

g) A replica of the nameplate with serial number, model number, manufacturer, operating conditions, etc. shall be provided for each pump.

8. Shop Painting

a) All iron and steel parts which will be in contact with pumped liquid or submerged after installation, including the inside of the casing, the impeller, and the discharge elbow, shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with the epoxy coating system specified. The coating shall have a dry film thickness of at least 10 mils and shall consist of a prime coat and one or more finish coats. At least 1 quart of the finish coat material shall be furnished with each pump for field touchup.

b) All other iron and steel surfaces, except stainless steel and machined surfaces, shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil resistant enamel or universal type primer suitable for top coating in the filed with a universal primer and aliphatic polyurethane system.

c) Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

B. Pump Control Systems

1. All components of the Pump Control Systems shall be properly designed and installed to meet all NEC and other industry standards, as well as all federal, state, and local requirements. Power service to wastewater pumping stations shall be 3-phase.

2. Submittals: Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section. The data and specifications for the Control Panel and Components shall include, but not be limited to, the following:

    1) Name of acceptable manufacturer, Square D, Cutler Hammer, or ABS
    2) Type and model

3) Enclosure rating
4) Dimensions of complete panel
5) Electrical schematics and wiring diagram
6) Liquid level sensors with mounting details and cable lengths, and pump controls
7) Published descriptive data on each item of equipment and all accessories, indicating all specific characteristics and options.

3. Enclosure: The Control Equipment Enclosure shall be a NEMA type 4X fiberglass and be of suitable size to house all components. A locking hasp shall be provided with no screw clamp type latches. Enclosure shall be fabricated from fiberglass. The top of the enclosure shall serve as a drip shield and the seam free sides shall prevent rain and sleet from entering. Inner panel shall be made of fiberglass.

4. Hinged Inner Door: An inner door shall be furnished. Overload reset push buttons, circuit breakers, switches pilot lights, and hr. meters shall be the only components accessible with door closed. Door shall be hinged and may be opened when service is required.

5. Line Terminal Block: A terminal block shall be furnished with properly sized line lugs to accept the main power source entering the control panel. Load lugs shall be adequate to accept all required load side wiring requirements. All live parts shall be fully shielded.

6. Motor Circuit Breaker (440-480 VAC): A properly sized, molded case, thermal hydraulic-magnetic circuit breaker or motor protector shall be provided for each pump motor. Line and load sides shall be equipped with lugs properly sized for the horsepower and current rating of the motor(s). The interrupting rating shall be 5,000 RMS symmetrical amps.

7. Transformer Primary Circuit Breaker: A properly sized, two pole, molded case circuit breaker shall be furnished ahead of the control power 120-VAC power transformer for short circuit protection and disconnecting power to the transformer. The circuit breaker shall conform to the Specifications for the motor circuit breaker(s).

8. Control Power Transformer: An industrial quality control transformer shall be furnished to provide control voltage. The transformer shall be furnished to provide more than adequate KVA rating to provide 120-VAC power for all items required in the control and alarm circuits. Transformer shall be protected in its secondary by properly sized supplemental circuit breaker(s).

9. Magnetic Contactors and Overload Relays: A magnetic contactor shall be furnished for each motor. A separate, panel mounted, 3 leg (three phase) overload relay or motor protector shall be supplied for each motor. Each leg of the overload relay shall be equipped with a properly sized overload heater. Electronic overloads are

not acceptable. Contactor and overload relay shall be properly sized for the required horsepower, voltage and phase.

10. Elapsed Time Meters: Six digit, non-resetable elapsed time meters shall be mounted in the control panel enclosure inner door to record the running time of each pump.

11. Condensation Strip Heater with Thermostat: A strip heater shall be furnished to prevent condensation within the control panel enclosure. The heater shall be controlled by a panel mounted, adjustable thermostat.

12. Phase & Voltage Monitor: A phase failure, reversal and under voltage monitor shall be supplied to prevent the motors from running under low voltage, phase loss, or phase reversal conditions. The monitor shall lock out the control circuit until the problem is corrected and automatically reset. The phase and voltage monitor shall be adjustable.

13. Lightning and Surge Suppressors: Suitable lightning and transient level surge suppressors shall be provided to protect motors and control equipment from lightning induced or other line surges. Surge suppressors shall meet current UL standards.

14. Thru - Door Overload Reset Push Buttons: Overload reset push buttons shall be provided for each overload relay. Push buttons shall be mounted so that with inner door closed, overload relays may be reset without entering high voltage compartment.

15. Switches: Heavy-duty industrial grade oil-tight 22mm switches shall be provided for each pump for "Hand/Off/Automatic" operation selection. All switch components shall be made of corrosion resistant metals and polyesters. Contact blocks shall be made of see-through polycarbonate for simplified inspection of contacts. Cams and strokers shall be Teflon impregnated for abrasion free service without lubrication. The switches required shall be as follows:

Switch Function (Name Plate)	Voltage
HOA	120 VAC

16. Pilot Lights: Full voltage, push to test, heavy-duty industrial grade oil-tight pilot lights shall be provided. All pilot light components shall be made of corrosion resistant metals and polyesters. An insulated socket shall be furnished to eliminate the possibility of shock during bulb change. Bulb change shall not require removal of the socket. Bulbs shall be “super bright” LED type. Lens shall be 22mm and made of lexan. The pilot lights required shall be as follows:

Pilot Light Function (Name Plate)	Voltage	Lens Color
PUMP 1	120 VAC	GREEN
PUMP 2	120 VAC	GREEN

17. Seal Fail Alarm Circuit with Test Push Button (Required for Submersible Pumps and Motors): The control panel shall be equipped with a conductance actuated control relay that shall respond to current from a moisture sensor in the pump seal chamber. Relay contacts shall be rated at 10 amps minimum. All molded structural parts shall be of high mechanical and dielectric strength, structural dimensionally stable, arc resistant, thermosetting plastic. Base plate shall be high strength, diecast aluminum alloy. Solid state type relays shall not be considered acceptable for seal fail monitoring applications. An amber alarm pilot light shall illuminate upon alarm condition. Each pilot light shall include contacts that shall allow testing of the seal failure circuit and pilot light bulb by pushing. Bulb change shall not require removal of the socket. Bulbs shall be “super bright” LED type.

18. Seal Failure Circuit Test Push Button (Illuminated): Heavy-duty industrial grade oil-tight push buttons shall be provided for each submersible pump motor. All push button components shall be made of corrosion resistant metals and polyesters. An insulated socket shall be furnished to eliminate the possibility of shock during bulb change. Bulb change shall not require removal of the socket. Bulbs shall be “super bright” LED type. Lens shall be 22mm and made of lexan. The push buttons required shall be as follows:

Push Button Function (Name Plate)	Voltage	Lens Color
P1 SEAL FAIL	120 VAC	AMBER
P2 SEAL FAIL	120 VAC	AMBER

19. Pump Alternator Circuit (For Duplex Pump Operation): The electro-mechanical alternator relay shall be of industrial design specifically for use in pump applications. It shall have single-pole double-throw heavy-duty 10-amp silver cadmium oxide contacts enclosed in a transparent cover. The snap action contacts shall transfer when the unit is de-energized. The circuit shall never be closed or opened while current is being conducted. The alternator circuit shall alternate the lead pump position between the pumps and shall allow the lag pump to start in response to a rising water level in the wet well. A four position switch shall be provided on the exterior of the pump control panel inner door. The switch shall have a position for: Pump 1, Pump 2, or Both.

20. Control Relay(s): Plug-in control relays with 120-VAC coils shall be provided as required. Contact rating shall be 5-amps (minimum). Sockets shall be of the same manufacture as the relays and hold-down clips shall be furnished to prevent relay

from sliding out of the socket. Relays shall have indicator lights showing when they are engaged.

21. High Wet Well Level Alarm: The control panel shall be provided with a suitable alarm circuit, activated by a separate level control. This alarm shall signal a high water condition in the wetwell. Terminals shall be furnished in the control panel for connection of externally mounted alarm devices. A red flashing light shall be provided as a visual alarm of the high water in the wet well condition. A continuous sounding alarm shall also be provided as an audible alarm of the high water in the wet well condition.

22. Liquid Level Controls: Level control will be achieved by means of a corrosion resistant level sensing **Pressure Transducer**. Float-actuated mercury level control switches shall serve as a backup for low level alarm and high level alarm functions. The mercury switch shall be encapsulated in polyurethane foam for corrosion and shock resistance. Level switches shall be weighted to hold desired position in the wetwell. The cord connection to the control shall be numbered 16-2, rated for 13-amps, and shall be type SJTO. To ensure optimum longevity contacts shall be rated for 20-amps at 115-VAC and shall be sealed in a heavy-duty glass enclosure. No junction boxes or cable splices of any kind will be allowed in the wet well. Level elevations shall be set in accordance with design drawings.

23. High Temperature Shutdown Circuit(s): The pump motor high temperature circuit shall provide terminals for connection of the leads from the temperature sensor provided in the pump motor windings. Upon a high temperature condition in the pump windings, the control power to the pump motor contactor shall be disconnected, thus stopping the pump motor. The pump shall automatically restart when the pump motor temperature returns to an acceptable level.

24. Ground Lug(s): Equipment ground lug(s) shall be provided for grounding the enclosure. The ground lug(s) shall be suitable for the service provided the enclosure sized per table 250-95 of the N.E.C. In all cases, the enclosure must be adequately grounded per article 250 of the N.E.C. except for fiberglass enclosures, where a grounding bus shall be provided.

25. Terminals: Terminals shall be provided for connecting mercury float switch leads, temperature sensor and seal fail sensor leads. Terminal blocks shall be rated for 600 volt use and accept a wire range of #22-8. All live parts shall have insulating walls on all sides of the lug. Blocks must be U.S. recognized.

26. Construction Standards: Subpanel shall be drilled and tapped to accept machine thread bolts (self-tapping screws are not acceptable). All control wiring shall be 16-AWG machine tool wire, Carol type 76512 or equal. All control wire shall be color coded or numbered in accordance with applicable standards. Power (motor) shall be in accordance with the current National Electrical Code. Major groups of wires shall be contained in plastic wiring trough equal to Panduit type E.

27. Nameplates: All indicator lights, alarms, selector switches, pushbuttons and major control system components shall be identified with engraved phenolic plastic nameplates, white lettering on a black background.

28. Control Panel: The control panel shall include the following elements:
    a) Separate Manual Disconnect for each pump with 2-pole adjustable overload protection for each phase;
    b) Magnetic starter for each pump motor with all leg quick trip ambient compensated overload protection for each motor. Overloads are to have an auxiliary contact for automatic dialer;
    c) Hand-Off-Auto selector switch for each pump;
    d) Automatic Electric Alternator with ability to designate either Pump 1 or Pump 2 as lead;
    e) Circuit Breaker for Control Circuit;
    f) Motor Thermal protection - Motor control circuit is to shut down if high temperature occurs. Manual resets to be provided;
    g) MPE LPC420-R-RM Level Control Mode;
    h) MPE Level Probe-Mode-LP-10;
    i) Backup float system with 3 floats shall be included as backup to the MPE Level Control;
    j) Test dial shall be provided to allow simulation of wet well level on MPE Control;
    k) ≥ 40 hpw shall be ‘soft start’;
    l) Horn signaling;
    m) Control Disconnect;
    n) Seal failure light for each pump and contact closure for automatic dialer (submersible installations only);
    o) High temperature light for each pump and contact closure for automatic dialer (submersible installations only);
    p) Running light for each pump;
    q) Non-resettable, elapsed time meter for each pump, reading in tenths of hours. Capacity 100,000 hours;
    r) High-level alarm light with Red Globe and contact closure for automatic dialer (remote mounting for “package” pumps station where panel is inside pump compartment);
    s) All necessary internal wiring, relays, etc. to provide the operation as described;
    t) All functions and internal wiring shall be labeled accordingly;
    u) Junction box shall be stainless steel and installed 4 feet above final grade to ensure water does not damage the internal wiring;
    v) Automatic Dialer / Scada;
    w) AC Voltmeter.

C. Alarm Dialer/SCADA/Telemetry

1. The pump station shall be provided with an alarm dialer in a lockable NEMA 4 enclosure. Hard line dialer units shall have a minimum of eight inputs and capable of additional expansion with battery backup and be the ANTX Dialer Scout or approved equal. The operating environment shall withstand from –5^{o} Fahrenheit to 130^{o} Fahrenheit with a 90% relative humidity, non-condensing. The alarm dialer shall operate on 120-VAC, and shall have a rechargeable battery backup capable of providing 4 hours of standby power with surge protectors on the power and telephone lines. The alarm dialer shall monitor high water conditions and grinder jams through normally open/normally closed contacts, shall have the capability of dialing four phone numbers, and shall work on a standard telephone service. The dialer shall be provided by a manufacturer listed on the design drawings. Seal failure and high temperature signals from all pumps shall be combined into a common “pump trouble” alarm to be transmitted from the dialer.

2. The pump station telemetry units shall be compatible with the Town’s current SCADA system. The Town shall not be required to purchase additional software to operate the telemetry unit.

D. Grinders

1. <u>General</u>

   a) A wastewater grinder shall be provided at each pump station for the intended purpose of grinding solids in the influent flow to the pump station.

   b) The entire grinder unit and accessories necessary to provide a fully functional wastewater grinder system, shall be supplied and warranted by a single manufacturer. The list of acceptable manufacturers shall be identified on the design drawings.

   c) The wastewater grinder shall be placed in a separate manhole or other influent structure prior to the wetwell, but still within the pump station site. The grinder shall be able to be removed from the influent structure without entering the influent structure by means of a stainless steel guide rail and stainless steel lifting chain with 4x6 lifting eyes at 10ft intervals starting at the top assembly. Another means of solids removal such as a trash basket or bar rack must be provided for installation when the grinder unit is out of service for extended periods.

   d) The wastewater grinder shall be electrically driven. The electric motor shall be a minimum 5 hp, 60 Hz, appropriately sized immersible motor. The motor shall be NEMA Design "B" and TEFC.

e) The wastewater grinder unit will have a complete and separate control panel providing all settings, monitoring, and control options required, as well as the ability to send alarm signals back to the alarm dialer and telemetry system.

f) The equipment shall be installed as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulations.

g) The grinder unit power supply shall match the pump station power supply. Standard pump station power supply is 3 phase AC power.

h) Identification. Each unit of equipment shall be provided with a corrosion resistant substantial metal nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, manufacturer's name and location, and important performance data.

2. Submittals

Submittals shall include electrical wiring diagrams complete for field wiring, terminal identifications, and control panel schematics. Electrical and control information shall be provided to allow coordination of field wiring to place the system in the desired operation. Submittals shall also include complete mounting and installation instructions, including size, length and spacing of all supports and anchor bolts. Submittals shall include painting instructions.

3. Quality Assurance

a) All equipment shall meet the requirements of the following standards:

1) ASTM A536-84 - Standard Specifications for Ductile Iron Castings
2) ASTM A36 - Standard Specifications for Carbon Steel Plate
3) AISI 304 - Stainless Steel
4) AISI 4140 - Heat Treated Hexagon Steel
5) AISI 4130 - Heat Treated Alloy Steel
6) AISI 1018 - Carbon Steel
7) 45-50 Rockwell C
8) National Electrical Manufacturers Association (NEMA)
9) National Electrical Code (NEC)
10) Underwriters Laboratory (UL and cUL)

b) Qualified manufacturers shall have a minimum of 5 years experience in the manufacturing of grinding and controlling equipment and a minimum of 20 installations at equivalent applications. Manufacturer shall submit a listing of names and dates of installations for verification by the Town of Apex Water Resources Department.

c) System Controls.

1) Each grinder system shall be provided with a single control panel suitable for mounting on an electrical rack, building wall, or as a secondary panel located under the weathershield. The control panel shall include all power and control circuits to provide the functional requirements specified herein.

2) A programmable controller shall be included in the panel. The programmable logic controller shall talk directly with the SCADA PLC without a third party communication device. Upon the grinder encountering a jam or overload condition, the controller shall stop the grinder and screen and reverse their direction of rotation to clear the obstruction. If the jam is cleared, the controller shall return to normal operation. If the jam condition persists, the controller shall repeat the reversing cycle up to eight additional times within 45-seconds (total of nine cycles) before signaling a grinder overload condition. Upon a grinder overload condition, the controller shall shut down the grinder and screen and activate an overload contact.

3) If a power failure occurs while the grinder is running, the grinder shall resume running when power is restored. A 0-60 second adjustable time delay device shall be included in the control panel to select time delay until restart after power restoration. If the grinder is stopped due to an overload condition and a power failure occurs, the overload indicator shall reactivate when power is restored.

4) The control panel shall provide overcurrent protection. The overload relay shall be adjustable so that the range selected includes the FLA rating and service factor. Grinder control panel shall be positioned either under the weather shield at the electrical riser or in the control building if included. A standalone control panel will not be accepted.

5) The control panel shall be equipped with a Hand-Off/Reset-Auto (HOA) selector switch. In the Off/Reset position, the motor shall not run. In the Hand position, the motor shall run continuously. In the Auto position, the grinder shall stop and start by remote control signal. The control panel shall include dry contacts for future addition by others of a remote maintained contact start/stop control signal when in Auto mode. The control panel shall not allow remote resetting of overload condition. Overload reset shall be accomplished by switching the HOA switch to the Off/Remote position.

6) The controller shall indicate each of the following statuses with an indicator light on the panel face:
    1) Power On
    2) Grinder Overload
    3) Motor Overload
    4) Run

7) Engraved phenolic laminate plastic identification nameplates, with white letters on black background, shall be provided for each switch, indicator light, gauge, etc. on the control panel and in the system.

8) The controller shall be properly rated three phase power, 60 Hertz.

9) A single enclosure shall house all power and control devices, relays, terminal blocks and motor starter. Control and indicating devices shall be mounted in the front of the enclosure. Indicating lights shall be integral transformer type with low voltage long life 6-volt lamps. Lamps and selector switches shall be heavy duty type. The control panel and all control devices shall be NEMA 4X. Enclosure shall be a NEMA 4X fiberglass reinforced polymer equipped with full hinged door, suitable for exterior mounting as shown on the drawings.

10) A lockable disconnect switch shall be provided on the outside of the control panel to disconnect power to the entire grinder system.

11) One set of normally open (NO) contacts shall be provided in the control panel for remote indication of each of grinder “fail” and grinder “run” status. Grinder overload, motor overload, oil overtemperature, low oil level and oil pressure alarms shall be ganged together to a common grinder “fail” alarm. The control panel shall provide 120 VAC power to these alarm circuits for remote indication at an existing alarm dialer system.

12) Contacts shall be provided for a future remote maintained contact emergency stop pushbutton, to be provided by others. These contacts shall be jumpered.

13) Motor starter shall be full voltage type with 120-volt operating coil and captive terminal screws. Overload relay shall be mounted directly to the contactor. The relay shall be sized to the motor full load amperage (FLA).

14) Control panel shall incorporate a manual momentary or spring return reversing switch for grinder control.

d) Spare Parts

1) The following spare parts shall be provided for each grinder as a minimum:
    1) Three (3) of each type of fuse found in the system
    2) Three (3) of each type of lamp bulb found in the system

2) The motor controller shall have sufficient space within its enclosure for the storage of motor controller spare parts. Grinder spare parts shall be packaged in suitable containers for long term storage and shall bear labels

clearly designating the contents of each package and the equipment for which they are intended.

E. Generators

1. General

a) Backup power shall be provided by an automatically starting on-site generator controlled by an automatic transfer switch. The generator shall be capable of supplying all necessary electrical power for complete operation of the pump station in the event of a failure of the electrical feed supplied by the local grid.

b) The entire generator set, switchgear, and accessories necessary to provide a fully functional backup power system, shall be supplied and warranted by a single manufacturer. The standby power generator set shall be Cummins, Kohler, Caterpillar, Generac, or Blue Star.

c) Each engine-generator unit, controls, and transfer switch shall be new and a standard product of a single manufacturer and shall be a packaged type unit, fully shop assembled, wired and tested, requiring no field assembly of critical moving parts.

d) The generator shall be sized to sequentially start and continuously run all pumps, motors, and other electrical equipment at the pump station site. Simultaneous starting of pumps is not required. The pump starting conditions (including delay timers, VFDs, soft starts, reduced voltage starters, etc.) should be verified for the particular site. The kW rating needed for a particular pump station shall be calculated by a licensed professional engineer by the generator manufacturer.

e) The voltage, amps, phase, etc., shall be coordinated with the design of the electrical equipment for the particular site. Generators will be 3 phase, 60 hertz, and capable of multiple voltages through re-strapping.

f) The engine generator set will have a complete and separate control panel mounted inside the generator enclosure providing all settings, monitoring, and control options required, as well as the ability to send alarm signals back to the alarm dialer and telemetry system.

g) Each unit of equipment shall be provided with a corrosion resistant substantial metal nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, manufacturer's name and location, and important performance data.

h) If the generator is elevated 30 inches or greater from the existing grade, a walk way with handrails shall be installed for access to all generator components.

i) The engine-generator set supplier shall be an authorized dealer of the engine-generator set manufacturer and shall be fully qualified and authorized to provide service and parts for the engine and generator 24 hours per day, 7 days per week from a location within a 100-mile radius of the installation site.

2. Submittals

a) The Contractor shall submit to the Town of Apex Water Resources Department, complete shop drawings for assembly and installation, together with detailed specification and data covering materials, drive unit, parts, devices and accessories forming a part of the equipment furnished, with the submittals section. The data and specifications for each unit shall include, but shall not be limited to, the following:

1) Manufacturer, model, and type: engine, alternator, enclosure, battery charger and battery, silencer, switchgear, transformer, etc.

2) Listing of standard and optional accessories.

3) Engine output horsepower and efficiency curves at specified conditions.

4) Engine mechanical data including heat rejection, exhaust gas emission data (maximum values at loads of 1/4, 1/2, 3/4, and full for: carbon monoxide (CO) (lb/hr), nitrogen oxides (NOx)(lb/hr), temperature (F), flow (ACFM)), combustion air and ventilation air flows, and fuel consumption at specified conditions.

5) Generator electrical data including temperature and insulation data, winding pitch, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.

6) Ratings at specified conditions: engine (net horsepower), engine (maximum performance horsepower bare engine), generator kW at specified power factor, volts, amperes.

7) Overall dimensions (length, width, height) and net weight.

8) Concrete pad recommendation (including size, length, and spacing of all necessary supports and anchor bolts) and layout/stub-up locations for electrical conduits.

9) Wiring diagrams and schematics for the entire system, including the engine control panel, generator breaker, automatic transfer switch, auxiliary transformer, and remote alarm indicators.

10) Calculations or test results showing compliance with specified motor starting and voltage dip requirements.

11) Line circuit breaker rating.

12) Control panel layout, identifying location of all instrumentation being supplied.

13) Operation instructions.

14) Letter from the engine-generator manufacturer confirming that the unit will provide the specified minimum kW rating at the specified design conditions and time duration.

15) Battery sizing calculations.

16) Battery charger sizing calculations.

17) Maximum output short circuit kvA available.

18) A certificate of compliance, when required.

19) Manufacturer's and dealer's written warranty.

3. Quality Control

a) Except where modified or supplemented by these Specifications, all equipment and materials shall be designed and constructed in accordance with the latest applicable requirements of the standard Specifications and codes of ANSI, ASTM, NEMA, IEEE, DEMA, EEI, HEI, ISO, NFPA, SAE, NEC, UL508, and other such regularly published and accepted standards as well as state and local codes.

4. Generator Equipment

a) Engine.

1) Engine shall be compression ignition type diesel, propane, or natural gas powered. Diesel fueled generators may be considered on large installations and shall be 4 stroke, liquid cooled, American made, with a minimum of 130 HP, or equal. Propane and natural gas fueled generators shall be specified on all small (less than 50 kW) stations. Any variance to this requirement shall be approved by the Water Resources Director.

2) Engine shall operate at an RPM of no more than 1800.

3) The engine will be equipped with an electronic governor to maintain 4% droop from no load to full load and +/-0.25% steady state. The electronic governor control shall be furnished as a complete governor and control package.

4) Engine shall have a dry type air cleaner, coolant, fuel filters, and oil filters with replaceable elements.

5) Engine shall be liquid cooled and shall have a radiator, coolant pump, thermostat, and fan. Air cooled engines may be approved by the Town for installation of less than 10 kW.

6) Governor shall be mechanical flyweight type with a speed regulation of 5 percent maximum.

7) Lubrication shall be by a positive displacement lube oil pump with positive pressure lubrication to all bearings. Full flow lube oil filter shall be provided.

8) Starting system shall be 12 volts, 35 amps with solid state voltage regulator. A battery float charger shall be provided.

9) An engine block heater shall be provided with control thermostat. The unit shall be 120 volt.

b) Generator.

1) The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel.

2) Voltage regulation shall be within +/-0.5% at steady state from no load to full load. The momentary voltage drop shall not exceed the specified percent without starter coils dropping out or stalling the engine at any time when applying or starting the specified loads. Recovery to stable operation shall occur within 2 seconds. Unit shall be capable of adjusting voltage under varying load conditions within 16 milliseconds.

3) The voltage regulator shall be a totally solid state design, and include electronic voltage buildup, volts per hertz regulation, overexcitation protection, shall limit voltage overshoot on startup, and shall be environmentally sealed.
4) The insulation material shall meet NEMA standards for Class H insulation and be fungus resistant.

5) The generator shall be a self-excited generator type. The excitation system shall be of brushless construction.

6) The generator shall be supplied with a 240V single phase anti-condensation heater protected by a circuit breaker inside the main control panel. When the generator set is not running the heater is automatically connected to the AC supply through a power relay mounted in the control panel. Upon receiving a start signal the AC supply is automatically disconnected by the power relay and automatically reconnected when the start signal is removed and the engine has stopped. A temperature set point shall determine the start and stop signal.

7) A sound retention enclosure shall be installed rated to a maximum decibel level of 65.

c) Fuel System.

1) Each engine-generator unit shall be furnished with a complete fuel system, including an integral fuel tank, fuel filter, fuel shut off valve, air filter, pressure regulator (if applicable), and piping along with all other accessories as required for proper operation. All items shall be suitable for the specified fuel and located inside the enclosure above the base plate and serviceable from inside the enclosure. The fuel system shall conform to NFPA 58.

2) The fuel tank shall have a capacity of at least 250 gallons to provide fuel for a minimum run time of 72 continuous hours at 100% prime load.

3) The fuel tank shall be double walled with a rupture basin of 110% capacity. It shall be pressure tested for leaks prior to shipment and have all necessary venting per US142 standards. A locking fill cap, a mechanical reading fuel level gage, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided. The fuel system shall require a polishing/filtration system for larger units to be determined by the Town. Any drain lines shall associated with the generator need to include brass plugs. Plastic plugs will not be accepted.

4) Fuel piping shall be designed for a working pressure of 250 psi. Sizing shall be in accordance with the manufacturer's recommendations, but not less than ½ inch in diameter.

5) A vapor withdrawal system shall be installed, to include a manual shut-off valve at the tank(s), a vaporizer, dry fuel filter, line service regulator, solenoid fuel shut-off valve to pen when engine runs, flexible pipe connection at the engine, and a gas flow regulator.

6) An 80% charge of propane in the propane storage tank shall be provided at the time of final acceptance.

7) Complete charges of antifreeze and oil shall be provided.

d) Lubrication.

1) Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

2) Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

3) Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

e) Alternator.

1) Alternator shall be revolving field, broad range, brushless type designed for minimum resistance, low voltage, waveform distortion, and maximum efficiency. Rotor shall be dynamically balanced permanently aligned to engine by flexible disc coupling. Maximum allowable voltage dip shall be 30%.

2) Exciter shall be 3 phase, full-wave rectified with silicon diodes mounted on a common motor shaft, sized for maximum motor starting.

3) Voltage regulator shall be solid state with silicon-controlled rectifiers with phase controlled sensing circuits.

4) Temperature rise at rated load shall be within limits for class F insulation in accordance with NEMA MG 1-22.40.

5) Insulation system shall be Class F in accordance with NEMA MG1-1.65. Rotor shall be vacuum impregnated with 100% solid epoxy resin for complete environmental protection. Stator shall be impregnated twice with varnish conforming to MIL-I-24092, Type M, Class 155.

6) Output circuit breaker shall be 3-pole, rated at 145% of alternator full load current.

f) Exhaust System.

1) Each engine-generator unit shall be furnished with a complete exhaust system including an exhaust silencer, exhaust piping, expansion joints, and accessories as required for a complete operating system.

2) A rain cap shall be provided to prevent rain from entering the exhaust pipe. The rain cap shall open from exhaust pressure from the engine and shall close when exhaust flow tops. The cap shall be stainless steel counter-balancing with vertical discharge.

g) Starting System.

1) Each engine-generator unit shall be furnished with a complete electric motor start system including starting motors, maintenance free starting batteries, battery pack with rack, cables, and battery charger.

2) The engine starter shall be a 12-volt DC or 24-volt DC, solenoid shaft, electric starting system with positive engagement.

3) The batteries shall be of the high rate, diesel starting, lead acid type. The batteries shall be sized for five 10 second cranks with battery and engine oil temperature of 30 degrees F and a battery end voltage of 70 percent of system voltage.

4) The battery charger shall be current limiting and shall be furnished to automatically recharge the batteries. The charger shall be dual charge rate with automatic switching to the boost rate when required. Output voltage regulation shall not exceed 1%. The charger shall include temperature compensation, NEMA 2 corrosion resistant enclosure, overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input, on/off switch, remote annunciation of loss of AC power, low battery voltage, and high battery voltage, AC input and DC output circuit breakers or fuses, floating voltage equalization, equalizing timer. AC input voltage shall be 120 volts or 240 volts, single phase.

5) The battery charger shall have a DC output suitable to supply power for all continuous loads and to recharge the batteries from a full discharge state to normal operating voltage within 8 hours.

6) The batteries, battery rack, and battery charger shall be located within the engine-generator enclosure. The battery rack frame shall be constructed of corrosion resistant material.

7) The engine-generator shall automatically supply power to the battery charger when it is operating and utility power is not available.

h) Cooling System.

1) Each engine-generator unit shall be cooled with unit-mounted radiator cooling system complete with radiator, expansion tank, water pump, belt-driven fan, fan guard, thermostatic temperature control, high-water temperature cutout, and all accessories as required for proper operation. The radiator shall be sized to provide sufficient capacity for cooling of the engine and all other accessories required for proper operation at an ambient temperature of 125 degrees F and taking into account the enclosure static pressure restriction. The fan shall draw air over the engine and discharge through the radiator.

2) The cooling system shall be filled with a permanent antifreeze mixture of the ethylene glycol type with rust inhibitor.

3) The engine generator unit shall have a 240V coolant heater protected by a safeguard breaker inside the main control panel. A controller shall be included to regulate the output temperature to within safe limits. When the generator set is not running the heater is automatically connected to the AC supply trough a power relay mounted in the control panel. Upon receiving a start signal the AC supply is automatically disconnected by the power relay and automatically reconnected when the start signal is removed and the engine has stopped.

i) Enclosure.

1) The engine-generator unit, fuel system, control panel, battery rack, battery charger, power panel, exhaust silencer, and other ancillary equipment, shall be housed in a weatherproof enclosure.

2) The enclosure shall consist of a roof, side walls, and end walls, and shall be weatherproof and sufficiently sealed to prevent the entry of rodents.

3) The enclosure shall be constructed of 12 gage or heavier metal panels that can be easily removed, or doors.

4) Doors shall be lockable with stainless steel hardware for access to the engine-generator, controls, and accessories. Doors shall also provide easy accessibility for maintenance. Doors shall have lock arm to prevent swinging when open.

5) The enclosure shall be provided pre-wired, requiring only external connection to the power panel and ATS.

6) Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves.

7) All moving parts inside of enclosure, including cooling fan and charging alternator, shall be fully guarded to prevent injury.

8) Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, engine generator unit, and enclosure.
9) An LED floodlight shall be provided inside and outside the enclosure to illuminate the generator equipment located within the interior of the enclosure. The floodlight shall be provided with a switch mounted on the generator control panel.

j) Control System.

1) Provide a generator set mounted control panel for complete control and monitoring of the engine and generator set functions. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged door secured with a twist lock latch. The panel door will have a voltage shunt switch. The panel itself shall be mounted on a separate support stand shall be mounted inside the enclosure such that the face of the panel faces outward and is isolated from vibrations of the engine/generator arrangement. Panel/breaker arrangements shall be mounted in such a manner as to not restrict access to the generator, engine, or other parts of the system that need periodic maintenance or repair.

2) The control panel shall be automatic and safety type and shall include at least all items required by NFPS 110 Level 1.

3) Panel shall include the following instrumentation and controls (at a minimum): AC voltmeter, AC ammeter, frequency/tachometer, engine running hours, coolant temperature gauge, lube oil pressure gauge, battery condition voltmeter, run/off/auto switch, emergency stop push-button, lamp test pushbutton, 7 position voltmeter phase selector switch, 4 position ammeter phase selector switch, 3 attempt start timer, cool down timer, remote start/stop terminals for 2-wire starting from ATS, charge rate ammeter, and exciter circuit breaker with manual reset.

4) Panel shall include the following emergency shutdowns with individual warning lamps (at a minimum): fail to start, high coolant temperature, low lube oil pressure, overspeed, overcrank protection, and alarm contact for auto-dialer (generator fail signal)

5) Panel shall include the following alarms with individual warning lamps (at a minimum): approaching low oil pressure, approaching high engine temperature, low/high battery voltage, battery charger failure, control switch not in auto mode.

6) Panel shall have at least 2 spare shutdown channels and 1 spare alarm channel and 4 additional fault channels for shutdown or alarm programming.

7) Panel shall have the ability to send up to 8 channels back to the existing SCADA system at the pump station.

8) Engine generator unit shall be provided with a fuel level gauge indicating relative fuel tank level in % values.

9) The panel shall be provided with a switched light that illuminates the panel face.

10) The panel shall include a stainless steel canopy with LED hood lights.

k) Circuit Breaker. Provide a generator mounted, molded case or insulated case construction, UL rated, 3 pole, and circuit breaker, sized as required. Breaker shall utilize a thermal magnetic trip. Breaker shall be housed in a steel NEMA 1 enclosure mounted on a separate support stand vibration isolated from the engine/generator arrangement. Bus bars, sized for the cable type shown on drawing, shall be supplied on the load side of breaker.

l) Receptacles. The engine generator will be supplied with two 120V, 20 amp duplex receptacles and two 120V, 20 amp twist lock receptacles. Receptacles will have individual circuit breakers, and will be placed inside the enclosure or will have weatherproof covers.

m) Shop Painting.

1) All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, engine, alternator, enclosure, piping, and valves shall be shop primed and finish painted prior to shipment to the site.

2) Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

n) Power Transformer. An externally mounted power transformer shall be supplied to provide required 240V single phase power to the coolant heater

and anti-condensation heater for each engine generator unit. The amp load shall be calculated by a licensed engineer or the generator manufacturer.

F. Automatic Transfer Switch

1. An automatic transfer switch (ATS) shall be provided on all pump stations for switching power to the onsite backup generator when normal grid power fails. The ATS shall be provided by the same manufacturer as the generator, and included under the same warranty as the generator.

2. General

   a) The ATS shall be rated for the voltage and ampacity as shown on the plans and shall have 600 volt insulation on all parts in accordance with NEMA standards.

   b) The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards. Designs which require cabinet ventilation are unacceptable and do not meet this Specification.

   c) The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.

   d) As a precondition for approval, all transfer switches complete with accessories shall be listed by Underwriters Laboratories, under Standard UL 1008 (automatic transfer switches) and approved for use on emergency systems.

   e) The withstand current capacity of the main contacts shall not be less than 20 times the continuous duty rating when coordinated with any molded case circuit breaker established by certified test data. Refer to required withstand and close ratings as detailed in this Specification.

   f) Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.

   g) Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA, and IEC.

   h) The transfer switches shall be supplied with a microprocessor based control panel as detailed further in these Specifications.

   i) The transfer switch shall be capable of detecting if the source switch was successful and if the pump station is receiving power. It shall also be capable

of transmitting a failure signal if it was not successful in switching sources and the pump station is not receiving power.

3. Sequence of Operation

a) The ATS shall incorporate adjustable three phase under-voltage sensing of the normal source and emergency source.

b) When the voltage of any phase of the normal source is reduced to 80% of nominal voltage, for a period of 0-10 seconds (programmable) a pilot contact shall close to initiate starting of the engine generator.

c) When the emergency source has reached a voltage value within 10% of nominal voltage and achieved frequency within 5% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.

d) When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be re-transferred to the normal source after a time delay of 0-30 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.

e) If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.

f) The transfer switch shall be equipped with a microprocessor based control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability.

g) The front panel display shall include indicators for timing functions, capability to bypass the TD on transfer or retransfer, and an ATS test switch and afford on-board diagnostic capability.

h) The control panel shall be provided with calibrated pots (accessible only by first opening the lockable cabinet door) to set time delays, voltage and frequency sensors. Designs which make use of DIP switches to render such adjustments are not acceptable. The ATS shall be capable of being adjusted while the controls are energized and the unit in automatic mode. Designs which force a "programming mode" or require the controls be de-energized during adjustment are unacceptable.

i) The control panel shall be opto-isolated from its inputs to reduce susceptibility to electrical noise and provided with the following inherent control functions and capabilities:

1) An LED display for continuous monitoring of the ATS functions.

2) Built-in diagnostic display.

3) Capability to support external communication and network interface through an optional RS 485 port.

4) Mechanical test switch to simulate a normal source failure.

5) Time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 minutes (continuously adjustable via a calibrated potentiometer factory set at 3 minutes).

6) Time delay on retransfer to normal source, continuously adjustable 0-30 minutes, factory set at 15 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

7) Time delay on transfer to emergency, continuously adjustable 0-15 minute, factory set at 1 minute.

8) An in-phase monitor shall be provided. The monitor shall compare the phase angle difference between the normal and emergency sources and be programmed to anticipate the zero crossing point to minimize switching transients.

9) An interval-type automatic clock exerciser shall be incorporated within the microprocessor.

10) Provide a momentary pushbutton to bypass the time delays on transfer and retransfer.

4. Construction and Performance

a) The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.

b) The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.

c) For switches installed in systems having ground fault protective devices, and/or wired so as to be designated a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.

d) The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 400 Amps.

e) The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Minimum UL listed withstand and close into fault ratings shall be as follows:

Any molded case breaker:

Size (Amps)	(RMS Symmetrical)
Up to 200	10,000
201-260	35,000
261-400	35,000
401-1200	50,000
1201-4000	100,000

Specific coordinated breakers:

Size (Amps)	(RMS Symmetrical)
Up to 150	30,000
151-260	42,000
261-400	50,000
401-800	65,000
801-1200	85,000
1201-4000	100,000

Current limiting fuse:

Size (Amps)	(RMS Symmetrical)
Up to 4000	200,000

*All values 480 volt, RMS symmetrical, less than 20% power factor.

f) A dielectric test at the conclusion of the closing tests shall be performed.

g) The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between a normal and

emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at 0.50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.

h) All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, fuses, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.

i) Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

j) A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection, or manual operation.

k) The switch shall be mounted in a NEMA 3R enclosure unless otherwise indicated on the plans.

l) Switches composed of molded case breakers, contactors or components thereof not specifically designed as an automatic transfer switch will not be acceptable.

804 Odor/Chemical Facilities

1. Odor control measures shall be evaluated for all possible sources of odor related to wastewater pumping systems. Source locations to be analyzed shall include, but not be limited to, the wetwell at the pump station, the force main discharge location, and force main air release valves. Odor control measures to be analyzed shall include, but not be limited to, oxidizing agent added to the wastewater, odor masking agents added to the air, activated carbon treatment, biofilter treatment, and wet scrubber treatment. Final determination of appropriate odor control measures shall be made by the Director of Water Resources.

2. Solutions that include chemical feed must consider the feasibility of chemical delivery to the site, provide appropriate chemical storage facilities including secondary containment, and must incorporate chemical feed systems as listed in the Town of Apex Approved Manufacturers List.

3. Odor control facilities not located on the pump station site (air release valves and discharge points, for instance) shall be constructed in underground vaults or if necessary to be above ground, shall be house inside a structure. Appropriate consideration shall be given to changing media or supplying chemical at the remote locations, as well as the safety of the maintenance staff while servicing the systems.

805 Inspections, Testing, and Training

A. Inspections

1. All materials and equipment used in the construction of the wastewater pumping system must be verified for compliance with the Specifications (or other approval granted by the Town) by the Infrastructure Field Technician prior to installation. Non-conforming materials or equipment shall be immediately removed from the job site.

2. Compliance with plans and Specifications shall be verified on a regular basis by the Infrastructure Field Technician.

B. Testing

1. General

   a) The Contractor shall furnish all materials, labor, and equipment to perform all testing and start up services. Water for testing purposes may be obtained from the Town of Apex. The Contractor shall reimburse the Town for all water used at Inside Utility Rates.

   b) All water or wastewater used during testing of the pump station, force main, or any of the systems described in this section, must be returned to the Town of Apex sanitary sewer system after proper coordination with the Town of Apex Department of Public Works and Utilities.

   c) Before the operational tests are conducted, the required copies of the Operation and Maintenance Manuals shall be delivered to the Town.

   d) The Town reserves the right to require further testing, as necessary, to assure that all components and infrastructure are performing in accordance with the manufacturer recommendations and Town Specifications. All testing, repairs and/or readjustments, and necessary re-testing, shall be at no additional cost to the Town.

   e) All on-site testing and/or installation verification shall be performed in the presence of the Infrastructure Field Technician or other representative authorized by the Town.

   f) All testing, installation verification, and training, shall be performed in the presence of, or by, an experienced, competent, and authorized manufacturer's representative.

g) Factory testing shall consist of testing all operating functions of the equipment under varying operating conditions to assure that it will perform as specified. Any specific testing that may be required is discussed under the individual equipment items below. Results of factory testing shall be presented to the Town prior to delivery of the equipment.

h) Installation Verification shall consist of a visit to the site by a manufacturer's representative to inspect, check, adjust if necessary, and approve the equipment installation. The manufacturer's representative shall certify that the equipment has been properly installed and lubricated, is in accurate alignment, and is free from any undue stress imposed by connecting piping or anchor bolts. Any specific verification requirements are discussed under the individual equipment items below. Results of the installation verification shall be presented to the Town prior to start-up of the equipment.

i) On-Site Testing shall consist of all manual and automatic operating functions under various operating conditions, including full load conditions. The equipment shall also be tested under adverse or emergency conditions. All alarms and remote signals shall also be tested. Any specific testing that may be required is discussed under the individual equipment items below. Results of the on-site testing shall be presented to the Town prior to final acceptance of the project.

j) All functions and systems of the pump station, even those not specifically listed below, shall be tested to ensure proper operation under normal and emergency situations.

k) All defective equipment or malfunctioning systems shall be replaced or corrected, and the full system placed in a fully operational condition to the satisfaction of the Infrastructure Field Technician.

l) Results of all factory testing, installation certifications, and on-site operational testing shall be provided to the Town of Apex in the final construction documents as described in the Submittals portion of this Specification section.

2. Pump Testing

a) Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Level A, with no minus tolerance or margin allowed. The test result report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall

include head, bhp (brake kW), pump efficiency, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

b) All pumps shall receive installation verification.

c) On-site testing shall be performed to the maximum extent possible (flow availability could limit the range of testing conditions).

3. Grinder Testing

a) Each grinder unit shall be factory tested.

b) Each grinder unit shall receive installation verification.
c) Each grinder unit shall receive on-site testing.

4. Generator Testing

a) Each engine generator set shall be fully assembled with its control panel and factory tested to demonstrate that the equipment conforms to specified requirements for load capacity. The tests shall consist of repeated starts and stops operation under a load bank at specified capacity for a minimum of 4 continuous hours, and tests to demonstrate that each safety shutdown device is working properly.

b) Each engine generator set shall receive installation verification.

c) Each engine-generator set shall receive on-site testing to demonstrate that the equipment conforms to specified requirements for load capacity, and starting duty. The complete system (engine, generator, control panel, and automatic transfer switch) shall be field tested together by the manufacturer or manufacturer's representative as a complete system to assure compatibility. A resistive load bank with temporary connections shall be provided to complete the field testing. Each unit shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. The testing shall consist of repeated starts and stops, a "cold start", normal operation under full load conditions at the specified power rating for a minimum of four continuous hours, and a one step rated load pickup test in accordance with NFPA 110. The following items shall be measured, recorded, and submitted in a field test report: outdoor ambient temperature, barometric pressure, kW output, engine speed (RPM), engine jacket water temperature, engine oil pressure, start time, completion time. Test reports shall verify that the specified tests have been performed and shall state results.

5. Automatic Transfer Switch Testing

   a) Each automatic transfer switch shall receive field verification.

   b) Each automatic transfer switch shall receive on-site testing in conjunction with the engine generator. At a minimum, the main power supply from the commercial power grid shall be cut and the switch shall automatically properly transfer the power feed to the standby generator.

6. Control System Testing

   a) All electrical, instrumentation, control, and telemetry systems shall receive on-site testing to ensure complete operation of all systems. At a minimum the testing shall include the following:

      1) Pump automatic control and operation
      2) Level-sensing equipment operation
      3) Alarm and telemetry system automatic operation
      4) Backup power generation automatic control and operation
      5) Vibration testing of all rotating equipment

7. Structure Testing

   a) Wetwells and other wastewater containing structures at the pump station shall be inspected and tested for watertightness. Structures shall be thoroughly cleared of dirt, mud, gravel and other foreign debris prior to testing.

   b) The watertightness test shall be performed in accordance with ACI 350.1R "Testing Reinforced Concrete Structures for Watertightness". If the structure is a small diameter precast manhole, a vacuum test in accordance with ASTM C1244 "Standard Test Method for Concrete Sewer Manholes by Negative Test Pressure (Vacuum) Test" may be used in lieu of the hydrostatic test.

   c) Watertightness testing shall not commence until the structure is fully assembled and backfilled.

   d) Any structure that fails to meet the requirements of the watertightness test shall be inspected, made watertight, and retested until the structure passes.

C. Operator Training

1. Suppliers of major equipment packages shall provide training to Town of Apex staff as to the proper operation and maintenance of their equipment.

2. Training shall be performed by an experienced, competent, and authorized manufacturer’s representative.

3. Training shall be at no additional cost to the Town.

4. Training shall be provided for, but not limited to, the equipment listed in the table below. The training times presented below for Operation Training and Maintenance Training are the minimum required. Complicated systems can require more than the minimum requirements.

Equipment System	Operation Training (hours)	Maintenance Training (hours)
Pumps and Pump Control Systems	2	4
Grinder System	1	2
Engine Generator and Automatic Transfer Switch	2	4
Chemical on/or Odor Control Systems	1	2
Alarm Dialer/ SCADA/Telemetry	1	0

5. Operational training shall include, but not be limited to, the following procedures or information: normal startup of the unit, normal shutdown of the unit, emergency shutdown of the unit, normal operation of the unit (typical temperature, pressures, signals, rpm, etc., for gages and instruments which are displayed on the panel), a presentation of all operational features (alternative run modes, bypasses, other features not typically used in day-to-day operation, etc.), presentation of all alarm signals, etc.

6. Maintenance training shall include, but not be limited to, the following procedures or information: standard lubrication procedures and schedules, removal and replacement of equipment, disassembly and re-assembly, replacement of wear parts or common replacement parts, standard troubleshooting procedures, etc.

7. Simplified operation instructions shall be submitted for review in accordance with the submittals section of this Specification. When the review is complete, the instruction sheets shall be printed on heavy paper or cardboard stock and laminated with clear plastic. Two copies of the laminated instructions shall be furnished with the unit. One copy shall be located or displayed at the control panel for the unit. The reserve copy shall be delivered to the Town. The instructions specified here are in addition to the required operation and maintenance manuals.

806 Force Main General

1. These Specifications apply to all force mains that are to be owned, operated, and maintained by the Town of Apex. Design of private pump stations and force mains and associated facilities is not covered by these Specifications or otherwise herein,

and the applicant should look for guidance from other appropriate agencies (NCDEQ, NC Plumbing Code, etc.).

2. All aspects of the design of wastewater force mains, and associated facilities shall, at a minimum, meet the requirements of the latest version of the NCDEQ "Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains". Requirements presented in the Town of Apex Standard Specifications hereunder that are more restrictive or go above and beyond the requirements of the Minimum Design Criteria are required by the Town of Apex.

3. All aspects of the design of pump stations, force mains, and associated facilities shall be submitted for review and approval to the Town of Apex Water Resources Department.

4. Wastewater force main interconnections shall be prohibited. All wastewater force mains shall extend to the nearest gravity sewer or pump station wet well that has sufficient long term capacity.

807 Wastewater Force Mains

A. Design

1. Force mains shall be installed with a minimum cover of 3 feet measured from the top of the pipe to the finished grade (or subgrade if installed under roadways). The engineering drawings shall include profile drawings for the entire length of the main.

2. All force mains shall be located within dedicated right of way of Town roads, outside of the right of way on NCDOT roads, or dedicated easements with a minimum width of 20 feet. When wastewater force mains are constructed adjacent to gravity sewer mains or for construction of parallel wastewater force mains, the minimum horizontal clearance shall be at minimum 7-ft from pipe edge to pipe edge when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to installation depth of 10-ft. Clearances for pipelines greater than 10-ft depth shall be designed by Engineer of Record and approved by the Town of Apex Water Resources Department. Easement widths outlined below shall be widened by at least the clearance between the pipelines when constructing a shared gravity sewer and wastewater force main corridor.

3. All force mains shall be installed outside of all Zone 1 and Zone 2 buffers whenever practical. Sewer main shall be installed outside of all floodplain unless No Practical Alternative is available and prior approval is obtained from the Water Resources Director.

Standard Easement Width for Sewer Force Mains

Pipe Depth*	Permanent Easement Width	Town Road R/W
8-ft or less	20-ft	Allowed
8-ft – 15-ft	30ft	As Specified by the WR Department
15-ft – 20-ft	40-ft	Not Allowed
Deeper than 20 ft	As Specified by the WR Department	Not Allowed

*Depth of the sewer main shall be measured from the top of the pipe to the final grade or road subgrade at the deepest point between manholes.

4. Dedicated easements for force mains and appurtenances shall be recorded as "Town of Apex Public Forcemain Easement". Town of Apex force main easements shall contain only Town of Apex utilities unless otherwise approved by an encroachment agreement.

5. Wastewater force main discharge manholes and intermediate air release locations that require odor control shall be provided with sufficient easement area to accommodate the odor control systems as designed by the Engineer of Record, whether utilizing passive, forced-air or chemical treatment for odor control. The maintenance easement for odor control systems shall be sized based on site specific conditions and shall provide sufficient area for routine maintenance operations, such as refilling media, chemicals, replacing equipment, etc.

6. Force mains shall discharge at the invert of the receiving manhole and shall be as close as possible to 180 degrees from the outlet pipe.

7. Force main design shall facilitate cleaning and inspection. The use of 90 degree bends is prohibited.

8. Force mains shall be constructed with a pigging/bypass connection located within 50-ft of the pump station valve vault.

9. Force main minimum design velocity shall not be less than 2-ft per second throughout the length of the force main. As a design preference, force main systems when operating at higher flows shall reach velocities of 3 to 5 ft/s to re-suspend any settled solids.

   Force main systems shall be of adequate sizing and design to effectively convey the ultimate peak flows as applied by the connected pump station to the discharge point.

10. The force main route shall be such that the number of high points requiring combination air valves is minimized to the extent possible. Combination Air Valves

rated for use with raw wastewater shall be installed at all the high points or runs exceeding 3000-ft on all force mains in accordance with the Standard Details. A high point shall be determined as any location where the vertical separation between the adjacent low point and high point in the force main is greater than or equal to 10 vertical feet.

11. Restraint:
    a) General: All pipe, valves, and fittings shall be restrained. Pipe joints shall also be restrained an adequate length away from valves and fittings in accordance with AWWA manual M41 (or the latest edition of *Thrust Restraint Design for Ductile Iron Pipe* as published by the Ductile Iron Pipe Research Association). In all cases, there must be a pipe restraint plan with the method of restraint to be used and the length of pipe to be restrained clearly identified on the plans at all necessary locations. The pipe restraint plan shall be included under the design responsibility of the NC Professional Engineer sealing the plan drawings. All restraint systems shall be factory produced by the manufacturer.

    b) Pipe Joints: The standard joint restraint method shall be to use manufacturer provided restrained joint pipe. Pipe up to and including 12-inches in diameter may utilize mechanical joint pipe with approved wedge action retainer glands (for the specified distance). All joint restraint products that include the means of restraint within the joint gasket shall be prohibited. Fusible C-900 DR 18 PVC may be utilized as an acceptable means of restraint.

    c) Valves: Valves shall be restrained in a manner consistent with operation as a dead end. This includes restraining the valve to the pipe and restraining a sufficient number of pipe joints on both sides of the valve to accommodate dead end restraint.

12. A plug valve shall be installed at least every 3000 feet of force main length.

13. All air release valves, plug valves greater than 12-inches, or other appurtenances that have moving or operating parts and require maintenance and routine access shall have a manhole placed over them or over the operating portion of the device.

14. Separation Requirements:

    a) Separation between Sewer Force Main and Storm Water Pipes:
    Sewer force mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or

minimum 500-psi, quick setting, non-excavatable flowable fill that meets or exceeds NCDOT Specifications.

b) Separation between Sanitary Sewer and Sewer Force Main:
There shall be a minimum 7 foot horizontal separation between parallel gravity and/or force mains in outfall locations when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft in outfalls.

c) Separation between Sewer Force Main and Water Main:
Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 5-ft lateral separation, and water line at least 18-inches above sewer force main measured vertically from top of sewer pipeline to bottom edge of water main.

d) Crossings (Water Main over Sewer Force Main): All water main crossings of sewer force mains shall be constructed in conformance with Town of Apex Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer force main. If 18-inches of clearance is not maintained, the water main and sewer force main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards. The ductile iron sewer force main shall extend 10-ft on both sides of the crossing. When the separation between pipelines is 18-inches or less, the void space between the pipes shall be filled with minimum 5000-psi, quick setting, and non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sewer force main crossings of potable water mains.

e) Crossings (Water Main under Sewer Force Main: Allowed only as approved by Town of Apex, when it is not possible to cross the water main above the sewer force main. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and both the water main and sewer force main shall be constructed of ductile iron in conformance with water main construction standards to a minimum of 10-ft on both sides of the crossing. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 5000-psi, quick setting, and non-excavatable flowable fill extending at least 3-ft on both sides of the crossing. In all cases the water main pipe shall be centered at the point of crossing with joints equally spaced from the point of crossing.

f) Sanitary Sewer Force Main and Stream Crossings:
The top of the sewer force main shall be at least three feet below the stream bed. If three feet of cover cannot be achieved, prior approval from the Water Resources Director must be obtained and concrete encasement and ductile iron pipe shall be required

Sewer force mains shall not be installed under any part of water impoundments or area to be impounded. Sewer mains shall not be installed through, above, or below any retained earth structure. Sewer main location and depth shall not be within the theoretical 1:1 slope of any impoundment dam or structure, or shall maintain a minimum of 10' horizontal separation from the toe of slope, whichever is greater. The entire easement shall be outside of the toe of slope, unless prior approval is obtained from the Water Resources Director.

The following minimum horizontal separations shall be maintained:

1) 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below).

2) 50 feet from any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below).

3) 10 feet from any other stream, lake, or impoundment (except as noted below).

4) 50 feet from private wells (with no exceptions).

5) 50 feet from sources of public water supply (with no exceptions)

Where the required minimum separations cannot be obtained, ductile iron sewer force main pipe with joints equivalent to water main standards shall be used. Steel casing and/or concrete may also be required for protection, at the direction of the Water Resources Director.

B. Materials

1. Pipe Materials

a) The minimum wastewater force main size shall be 4-inches in diameter.

b) Ductile Iron Pipe or PVC C900 DR18 shall be required for all wastewater force mains.

c) Ductile iron pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness

design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DI Wastewater Force Mains

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
4-8 -inch	type 1	350 psi	3-16 feet
4-8 -inch	type 4	350 psi	16-20 feet
10-12 -inch	type 1	350 psi	3-10 feet
10-12 -inch	type 4	350 psi	10-20 feet
14-20 -inch	type 4	350 psi	3-25 feet
24 -inch	type 4	350 psi	3-25 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

All ductile iron pipe shall be marked in conformance with ASTM A-746.

The following table lists approved manufacturers of DIP, DIP fittings, and RJDIP that are allowable for installation within the Town's system.

Product Category	Approved Manufacturer	Model/Series	Pressure/Load Rating	Reference Standard	Requirements
Ductile Iron Pipe 4-inch & Larger Diameter Protecto 401 Lined	US Pipe	Tyton Joint	250-350 psi	AWWA C150 and C151 and DIPRA Standards	40-mils of Protecto 401 Lining (lining must be less than 1 year old); McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Fittings 4-inch & Larger Diameter Protecto 401 Lined	Sigma	Mech. Joint	250-350 psi	AWWA C110/C111 and AWWA C153	Shall always meet or exceed pipe pressure rating
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			
Ductile Iron Restrained Joint Pipe 4-inch & Larger Diameter Protecto 401 Lined	US Pipe	TR Flex	250-350 psi	AWWA C150 and C151	Boltless restraint unless otherwise specified
	American (ACIPCO)	Flex Ring			
	McWane	TR Flex (pipes 24" and smaller)			

d) All ductile iron wastewater force mains and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, as manufactured by Protecto 401. The interior coating shall be applied at a nominal dry film interior thickness of 40-mils. All DIP bells and spigots shall be lined with 8-mils of Protecto 401 joint compound applied by brush to ensure full coverage. All pipe supplied with Protecto 401 interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected. Patching of Protecto 401 coating defects after installation shall not be approved. Protecto 401 lined pipe must be installed within one year of the application date on the pipe.

The liner manufacturer shall have a minimum of ten (10) years of successful experience and be able to demonstrate successful performance on comparable projects.

Permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

e) PVC pipe shall conform to AWWA C900 standards along with the following requirements:
    1) Outside diameter shall conform to that of ductile iron pipe.
    2) Pipe shall have plain end and elastomeric gasket bell ends.
    3) Green in color.

f) Pipe fittings shall be made of ductile iron designed and manufactured per AWWA C110 or C153. All fittings up to and including 24 inches in diameter shall be designed for a minimum internal pressure of 350 psi, unless otherwise approved by the Town of Apex. Fittings shall be mechanical joint or proprietary manufacturer provided restrained joint. Gaskets shall be in accordance with AWWA C111. All fittings shall be interior coated with Protecto 401 as specified herein for ductile iron pipe. Two 45 degree fittings shall be used in lieu of 90 degree fittings in all horizontal and vertical installations.

g) Restrained Joint Pipe shall be the boltless type unless otherwise approved. For installations requiring welded locking rings, the rings shall be factory welded. The restrained joints shall provide a minimum of 4-degrees of deflection for pipe sizes, 4-inches through 12-inches in diameter.

   All proprietary pipe restraint systems shall be approved by the Town of Apex and provided in compliance with all standards for coatings, linings, pressure classes, etc. as required for PVC C900 or ductile iron pipe. All restrained joint pipe shall be installed based on laying conditions, pressure class, etc. as required for typical ductile iron pipe.

   Pipe and fitting manufacturer(s) must have a supplier within 200 miles of the Town of Apex.

2. <u>Manhole Materials:</u>
   a) All sewer force main manholes shall be installed according to Section 0700 of the Town of Apex Standard Specifications when design and installation criteria are not otherwise covered herein.

   b) All force main discharge locations (including all downstream manholes within 1,200 feet) and other manholes for wastewater force mains (excluding those housing large diameter plug valves) shall be epoxy coated at minimum 80-mils thickness.

   c) Force Main Manhole Epoxy Coating: Sewer force main receiver manholes, sewer force main combination air valve manholes and other concrete structures subject to high levels of hydrogen sulfide gas shall be provided with an approved monolithic epoxy coating system consisting of a 100% solids,

solvent-free, two-component epoxy resin that meets the following Specifications for up to 100 mils of coating with a manufacturer approved set time of 6-hours or less.

1) Surface Preparation: Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required).

   Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

2) Installation: A minimum 80-mils thickness shall be applied to new manholes (120-mils for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

   Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations.

   Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

   If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

d) Force Main Receiver Manholes: Sewer force mains shall not discharge directly into existing gravity sewer lines. Sewer force mains shall typically discharge into a receiver manhole that has been epoxy coated as specified herein. The receiver manhole shall be provided in the typical eccentric tapered design at minimum 5-ft diameter. The bench shall be sloped up to 8-inches from the invert channel to the manhole wall. The invert shall be provided with a gradual upsloping alignment from the force main entry to the gravity transition point. Sufficient grade shall be placed on the invert such that wastewater falls back into the force main when the pumps are not in operation creating a vapor lock between the force main and the manhole. Drop connections into force main receiver manholes shall be prohibited.

The interior surface of the receiving manhole at the discharge end of the force main and all manholes within 1,200 feet downstream of a force main connection shall receive 2 coats of Sherwin Williams Sher-Flex or equivalent. Coatings shall conform to US Army Corps of Engineers Specification C-200. The coating shall have a total dry film thickness of 80-125 mils, and all blemishes shall be touched up prior to acceptance.

Force mains shall discharge at the invert of the receiving manhole and at an angle which is as close as possible to 180-degrees of the outlet pipe.

e) Combination Air Valve Manholes: Manholes for combination air valve installation shall be provided in flat top configuration to accommodate the excess length of wastewater combination air valves. In cases where the combination air valve assembly shall be located in a paved area, provide typical eccentric, tapered manhole design with typical manhole frame and cover for paved areas. The minimum manhole diameter for combination air valve assemblies shall be 5-ft. Minimum 6-ft diameter manholes shall be used with force mains 20-inches and larger and when an odor control system is required. Any manholes located in NCDOT or street right-of-way shall be provided flush with finished grade. ARVs shall be 2-inch and manufactured by ARI, model D-02P sewage dual ARV with plastic body.

C. Installation

1. General

Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.

Pipe trench excavation and backfilling shall be performed in accordance with Section 0450 of these Specifications.

Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be plugged or capped when pipe laying is not in progress.

All pipe shall be constructed with at least 48 inches of cover below the finished surface grade. Pipe shall be laid on true lines as directed by the Engineer. The wastewater force main shall be installed at a grade which will allow air to migrate to a high point where the air can be released through an air valve. A minimum pipe slope of 1 foot in 500 feet should be maintained and there shall be no intermediate high points in the line.

Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected. All transition joints between different types of pipe shall be made with transition couplings approved on shop drawings showing the complete assembly to scale.

Forcemains shall not be installed within roundabouts or alleys.

2. Utility Coordination

Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

D. Valves and Appurtenances

1. General: The rated working pressure of all valves and appurtenances shall meet the maximum design pressure of the pump station and pipeline.

2. Check Valve: Check valves shall be iron bodied, fully bronze mounted with bronze clapper disc and bronze seat ring, and shall have a spring loaded lever arm capable of being mounted on either side of the valve.

3. Plug Valve: Plug valves shall be non-lubricating, eccentric action and resilient plug facing with heavy duty Type 316 stainless steel bearings. Plug valves shall be

designed for a minimum working pressure of 175 psi for valves 12” and smaller, 150 psi for valves 14” and larger. Valves shall be bi-directional and meet the pressure rating in both directions of flow. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable.

All plug valves 12” and smaller shall have round port design that provides a minimum 80% port area. The valve plug shall be ductile iron ASTM A536 Grade 65-45-12 up to 20-inches in diameter, with EPDM, Buna N, or Neoprene resilient seating surface to mate with the body seat. Valves 24-inches and larger may have plugs made of cast iron in accordance with ASTM A126 class B. Large plug valves with rectangular plugs shall provide clean passage for a solid sphere of at least 67% of the adjoining pipe diameter to facilitate pigging of the force main. Force main plug valves with rectangular port shall be "full-port" cross-sectional area perpendicular to the flow of at least 100% of the adjoining pipe.

All buried plug valves shall be provided with worm gear actuators. All plug valves shall be buried and provided with a 2-inch operator nut and valve box as shown in the details. Plug valves greater than 12-inches shall be installed such that the actuator and gearing is accessible in a manhole as shown in the details. All plug valves shall be provided with typical mechanical joint end connections and restrained with wedge action retainer glands on both ends of the valve assembly as described herein.

Valves shall be installed according to the manufacturer’s recommendations. Typically for wastewater this means installing the seat side toward the pump station so that the flow is against the face of the plug in the closed position. In the open position, the plug should rotate up to the top of the pipeline which may require installing the valve on its side.

4. Rubber Seated Ball Valve: For larger diameter force mains where plug valves are not available, rubber seated ball valves shall be of the tight-closing, shaft-mounted type that fully comply with AWWA Standard C507 to provide a full port unobstructed waterway with no additional pressure drop. Design pressure ratings shall be 150 psi or greater and provide tight shutoff against flow. With the valve in the closed position, the rubber seated valve shall be bubble tight at rated pressure. All ball valves shall be provided in an epoxy coated manhole with worm gear actuators and a handwheel.

5. Valve Box Covers: Force main plug valves or ball valves shall have valve box covers and/or manhole lids with the word "Sewer" cast into them.

6. Combination Air Valves shall be provided to purge air from the system at startup, vent small pockets of air while the system is being pressurized and running, and prevent critical vacuum conditions during draining. Combination air valves

approved for use in wastewater force main installations shall be installed at all high points of wastewater force mains 6 inches in diameter or larger and at other locations, such as major changes in slope, as directed by the Town. A high point shall be determined as any high location where the difference between the high elevation and adjacent low elevation exceeds 10-ft unless otherwise determined by the Director of Water Resources based on special circumstances. The combination air valve shall automatically exhaust large volumes of air from the system when it is being filled and allow air to re-enter the pipe when the system is being drained. The wastewater force main shall be installed at a continuous grade between low and high points without intermediate high points unless an air release valve is being installed. A minimum pipe slope of 1 foot in 500 feet should be maintained. Combination air valves shall be sized by the Engineer and approved by the Town.

a) Combination air valves shall be of the single housing style with Type 304 or 316 stainless steel body that combines the operation of both an air/vacuum and air release valve. The valve must meet the requirements of AWWA C512 and be installed in accordance with the Details. The valve shall have a minimum 145-psi working pressure unless the pipeline design requires a higher pressure rating.

b) The valve shall have a minimum 2-inch male NPT inlet for a 2-inch valve assembly. Combination air valves sized from 3-inches to 8-inches shall be provided with studded inlet connectors or flanged connections. The combination air valve shall be provided with cylindrical shaped floats and anti-shock orifice made of high density polyethylene. Combination air valves with spherical floats shall not be accepted. All combination air valves shall be installed in accordance with the Details.

c) Installation of Combination Air Valve Assembly:

    1) The Engineer of Record shall provide ample depth of installation to accommodate the extended height of combination air valves for wastewater force mains. All combination air valves shall be connected to the main by an MJ x FLG tee with the branch diameter equal to at least half of the main diameter.

    2) The 2-inch combination air valve shall be provided with male NPT threads and isolated with a 2-inch gate valve. The isolation valve shall be provided with NPT threads and connected with brass or bronze piping.

    3) Combination air valves 3-inches and greater shall be connected by flange or studs. If needed due to a larger diameter tee, a flanged reducer shall be provided between the tee and the isolation valve. Gate valves shall be used for 3-inch assemblies. Combination air

valves 4-inches and larger shall be isolated with a plug valve. In all cases the isolation valve shall be sized equal to the combination air valve.

4) The ARV shall be installed in a 5 foot diameter manhole per the standard detail. The manhole interior surface shall receive two coats of Sherwin Williams Sher-flex or equivalent with a total dry film thickness of 80-125 mils, and all blemishes shall be touched up prior to acceptance.

7. Pigging Station: Force mains shall be constructed with a pigging/bypass connection located within 50-ft of the pump station valve vault. This pigging leg shall consist entirely of Protecto 401 coated ductile iron pipe of the same diameter as the main. A restrained MJ wye shall be provided in the main line and valved on each branch. The pigging leg shall extend out of the ground and be closed with a blind flange. The protruding pipe shall be protected by concrete bollards spaced 6-ft apart.

8. Bypass Connection Assembly: On some wastewater force mains, an additional bypass connection assembly may be required. The size, criticality and proximity to a downstream manhole will be important factors in the need for this connection. The bypass assembly shall include either a ball valve or plug valve assembly for isolation from the primary wastewater force main. Additionally, the primary force main shall be provided with a main line plug valve or ball valve on the upstream side of the bypass assembly to prevent bypass flow from draining back to the pump station. The bypass assembly shall be brought to the final graded surface with a visible blind flange assembly for connection by an outside pumping contractor.

9. Force Main Odor Control Systems: Force main odor control shall be included in the design plans for any proposed force main at discharge locations, intermediate air release locations and otherwise as directed by the Town of Apex Water Resources Department. In limited cases, air release valves located in isolated areas may be approved without odor control systems. The suggested odor control technology shall be designed by the Engineer of Record to achieve 95% or greater hydrogen sulfide removal. All systems, including those utilizing activated carbon, shall be manufactured specifically for addressing hydrogen sulfide gas. Forced air systems should be avoided due to the need to include provisions for electrical power to the odor control system. For all odor control systems, the Engineer of Record shall provide sufficient easement area for long term maintenance of the system.

10. Marker Posts: Force mains shall be marked with a plastic marker at every valve, every horizontal fitting, and spaced every 1,000 feet along the force main. The post shall having a minimum diameter of four inches and a minimum bury of thirty inches with a minimum of four feet exposed. The exposed portion shall be painted green and label “Apex Sewer”. Marker posts shall be installed through outfalls,

easements, all non-residential areas, and as directed by the Water Resources Director. Valves shall have marker posts only when they are installed outside of paved areas.

808 Force Main Inspections and Testing

A. Inspections

1. All materials and equipment used in the construction of the wastewater pumping system must be verified for compliance with the Specifications (or other approval granted by the Town) by the Inspector prior to installation. Non-conforming materials or equipment shall be immediately removed from the job site.

2. Compliance with plans and Specifications shall be verified on a regular basis by the Inspector.

B. Testing

1. General

   a) The Contractor shall furnish all materials, labor, and equipment to perform all testing. Water for testing purposes may be obtained from the Town of Apex. The Contractor shall reimburse the Town for all water used at Inside Utility Rates.

   b) All water or wastewater used during testing of the pump station, force main, or any of the systems described in this section, must be returned to the Town of Apex sanitary sewer system after proper coordination with the Town of Apex Water Resources Department.

   c) All on-site testing and/or installation verification shall be performed in the presence of the Inspector or other representative authorized by the Town.

2. Force main Testing

   a) The force main shall be tested in accordance with the water main standards set forth in Section 600.

   The following tests must be run on coupons from factory lined ductile iron pipe:
   a) ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.
   b) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
   c) Immersion testing rated on using ASTM D-714-87.
      1) 20% Sulfuric Acid – No effect after two years.
      2) 140°F 25% Sodium Hydroxide – No affect after two years.

3) 160°F Distilled Water – No effect after two years.
4) 120°F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.

d) An abrasion resistance of no more than 3 mils (0.075mm) loss after one million cycles using European Standard EN 598: 1994, Section 7.8 Abrasion Resistance.