

Design Guidance Manual



Effective Date: 01-01-23

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I. GENERAL REQUIREMENTS

A. Purpose and Intent

1. The purpose of this Manual is to establish uniform minimum standards for the design of construction projects within the service area for Cape Fear Public Utility Authority (CFPUA). This Manual is intended to supplement and to be used in conjunction with:
 - a. CFPUA Standard Technical Specifications
 - b. CFPUA Materials Specifications Manual (MSM)
 - c. CFPUA Standard Construction Details
 - d. CFPUA Development Process & Procedures Manual
 - e. Requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good engineering practice and specific program needs.
2. Omission of reference in these guidelines does not relieve responsibility for compliance with applicable requirements.
3. Adherence to State and CFPUA standards, including this Manual will ensure a quality water and wastewater system for the CFPUA customers, with increased system life and reduced overall cost of operation and maintenance.
4. The standards established by this Manual are applicable to all new development and CFPUA capital projects. It is recognized that occasionally limitations imposed by existing structures, ownership, land use, or other extenuating circumstances do not allow these standards to be applied in their entirety. In these cases, these standards will be applied to the extent that technical, legal, economical, and environmental considerations allow.
5. Deviations from the minimum standards set forth in this manual shall be granted on a case-by-case basis upon approval by CFPUA. Such deviations shall be based upon specific detailed situations that are clearly justified resulting in preferable environmental impacts and are not detrimental to the public welfare, or injurious to property or improvements in the surrounding area.
6. Project types listed below are not addressed by this Manual. Their design, approval, and construction will be addressed on a case-by-case basis.
 - a. Water and wastewater treatment systems.
 - b. Water booster pumping stations.
 - c. Major wastewater pumping stations with pumping units generally greater than 1,000 gpm.
 - d. Water storage facilities.
 - e. Vacuum sewers.

B. Location of Water & Sewer Facilities

1. Public rights-of-way and/or easements are required by CFPUA to properly maintain water and sewer lines.
2. The water and sewer lines can be located either in the public right-of-way (the streets and roads) or on private property including private rights-of-way, in dedicated utility easements, typically along property lines. When possible, locate utility lines in dedicated road rights-of-way with water and sewer on the opposite side of the road from each other.

3. Installing water and sewer lines in public rights-of-way is subject to the approval of the Authorities Having Jurisdiction (AHJs):
 - a. North Carolina Department of Transportation (NC DOT). Refer to:
 - Policies and Procedures for Accommodating Utilities on Highway Rights of Way.
 - Utility Policy Manual
 - b. City of Wilmington (COW): refer to [Right of Way Permits](#) on www.wilmingtonnc.gov.
 - c. Water and sewer lines installed in road rights-of-ways shall comply with the requirements of the Authority Having Jurisdiction. NC-DOT generally does not allow utilities to be installed under asphalt. COW generally prefer utilities to be installed under asphalt and sidewalks to allow space for planting street trees.
4. Easement widths shall be as follows:
 - a. Gravity sewer – easements not less than 30 feet wide
 - b. Water mains – easements not less than 20 feet wide
 - c. Sewer force mains – easements not less than 20 feet wide
 - d. Wider easements shall be required depending upon the depth of the mains and the number of water and/or sewer mains in a proposed utility easement.
5. Water and sewer lines shall not be located in surface water or wetlands, unless approved by North Carolina Department of Environmental Quality, US Army Corps of Engineers, and CFPUA.
6. Coordination with owners of existing rights-of-way and easements: Other entities that may own rights-of-way and easements include railroad, electric power companies, natural gas companies and others. Secure encroachment agreements when CFPUA facilities will infringe on such rights-of-way and easements.
7. Location of water services shall be approved by CFPUA prior to installation.
8. For major subdivisions being constructed in multiple phases, each phase's water main extension shall terminate at a valve and sewer main extension shall terminate at a manhole.
9. Proposed water and sewer system extensions to development on non-subdivided tracts of land or on lots accessed by private access easements:
 - a. Shall be required to be permitted as private systems served by a master meter and separate fire line if deemed to be in the best interest of CFPUA from a water quality, operational, maintenance or public health, safety, and welfare viewpoint.
 - b. Will be allowed to be permitted as an extension to the public system, if in the best interest of CFPUA from a system interconnectivity, looping, and water quality viewpoint, but must be installed in public rights-of-way and/or public utility easements approved by CFPUA.
 - c. Conditions that typically lead to private utility permitting are utilities that serve only the development, a single point of water connection, utilities under parking areas, and parcels served by private access easements. Large non-subdivided parcels shall be served by private utility extensions unless the development substantially meets these guidelines:
 - Meets CFPUA standards
 - Connectivity through the site to other land
 - Pump station meets ordinance criteria for public pump station
 - Pump station accessible to CFPUA's largest vector truck
 - Utilities in recorded easements to CFPUA standards, or

- Public right-of-way, or
- Private right-of-way to public standards
- Minimize other utilities in private right-of-way, especially storm drains from impacting maintenance of CFPUA infrastructure and provide a hold-harmless agreement to CFPUA for conflicting utilities (i.e. stormwater) if requested.

C. Water & Sewer Facility Separations

1. NC – DEQ Rules

North Carolina – Department of Environmental Quality, Division of Water Resources rules for separation of water and for separation of sewers are contained in 15A NCAC 18C and 15A NCAC 2T, respectively.

- a. Separation of water mains and sewers is regulated by 15A NCAC 18C [Rules Governing Public Water System](#). 0906 RELATION OF WATER MAINS TO SEWERS, which states:
 - Water mains shall be laid at least 10 feet laterally from existing or proposed sewers. If conditions exist that prevent 10 feet lateral separation the bottom elevation of the water main shall be at least 18 inches above the elevation of the top of the sewer.
 - Water mains crossing over sanitary sewers: Water mains shall be laid with the bottom elevation of the water main at least 18 inches above the top elevation of the sewer. One full length of water pipe shall be located so that both joints will be as far from the sewer as possible.
 - Water mains crossing under sanitary sewers: If the separation distances required by this Rule cannot be met and the water main shall cross under the sewer, a deviation to this Rule will be considered on a case-by-case basis.
 - Water mains crossing under storm sewers: CFPUA preference is for water mains to be located above storm sewer, however, with approval by CFPUA, water mains shall cross under storm sewers with a minimum vertical distance of 12 inches between the outside of the water main and the outside of the storm sewer. At crossings, one full length of water pipe shall be located so both joints will be as far from the storm sewer as possible. Special structural support for the water and storm sewer pipes will be required.
 - Special conditions: If an engineer demonstrates it is impracticable to maintain the separation distances required by this Rule, the deviation may be approved on a case-by-case basis with consideration of pipe material, pressure ratings, soils conditions and ability to provide adequate workspace for repair and replacement.
- b. Minimum separations from sewer systems, and exceptions, are provided in 15A NCAC 2T [Waste Not Discharged to Surface Waters](#). 0305 DESIGN CRITERIA in Paragraph (f) and Paragraph (g), respectively, and state to provide:
 - 18 inches vertical separation from storm sewers.
 - Separation from water mains as stipulated in the Rule Governing Public Water Systems.
 - 18 inches vertically (below) or 2 feet laterally from reclaimed water lines.
 - 100 feet from any private or public water supply source.

- 50 feet from classified waters, high water (or tide elevation) and wetlands.
- 10 feet from any other stream, lake, impoundment or ground water lowering and surface drainage ditches.
- 5 feet from building foundations
- 10 feet from basements
- 10 feet from top slope of embankments or cuts of greater than 2 feet in height.
- 5 feet from drainage systems and interceptor drains
- 10 feet from swimming pools.
- 36 inches below final grade (minimum cover), unless ductile iron pipe is provided and, where subject to traffic load, proper bedding is provided to develop supporting strength.

2. Surface Water Crossings

Surface water crossings, whether over or under water, present unique challenges. CFPUA shall be consulted before plans are prepared. The following guidelines shall be used as a minimum:

- a. Underwater crossings shall include a minimum of three (3) feet of cover from the deepest point to the crown of the pipe. Only fused or welded pipe joints will be allowed.
- b. Above water crossings, exposed or shallow bury, shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement. The pipe material and joints must be designed appropriately and will typically be ductile iron.
- c. Valves shall be located on each side of the crossings so that the section can be isolated for testing or repair. The valves shall be easily accessible and not subject to flooding.

3. Special Conditions

- a. Interference Structures – Manhole interference structures for water/sewer mains intersecting storm drains shall be approved by CFPUA and other agencies having jurisdiction on a case-by-case basis.
- b. Septic Fields – When new water or sewer service is extended to areas with active septic fields, surveys must be conducted by the design engineer to identify the location of the septic fields so adequate separations are maintained from the new water/sewer facilities.
- c. Private Wells - When new water or sewer service is extended or relocated, surveys must be conducted by the design engineer to identify the location of potable or irrigations wells, so adequate separations are maintained from the new sewer facilities.
- d. When regulatory separations cannot be achieved without hardship, design engineer shall contact NC-DEQ for variance of special permitting of designs such as double-wall manholes or pipe encasements to prevent cross-contamination.
- e. Water mains, service laterals and appurtenances will not be placed in contaminated areas unless piping material, including gaskets, are adequate to protect the water quality.
- f. Water mains shall not be installed less than ten (10) feet from any wastewater tile field or spray field.

D. Design Drawing Submittals

1. CFPUA's requirements for design drawing submittals are stated in Technical Specification Section 01 78 39 - Project Design Drawing Requirements. Additional information is presented in Chapter 3.1 Professional Engineered Plans Submitted to CFPUA, of the Development Process & Procedures Manual.
2. CFPUA's Standard Construction Detail drawings are not to be considered "pre-engineered". Use of the Standard Construction Detail drawings are to indicate CFPUA's requirements for layout and installation of typical utility system accessories and appurtenances. The use of Standard Construction Detail drawings does not relieve the developer/developer's engineer from all liability associated with the sealed design drawing submittals. CFPUA's Standard Construction Details may be modified by the design engineer to meet specific project requirements.
3. All project specific CFPUA Standard Construction Details shall be included on the design drawings.
4. The Standard Construction Detail drawings associated with wastewater pumping stations are intended for guidance only. These detail drawings are not scale drawings and are not reflective of the pumping station being depicted in the design drawing submittal. Therefore, show all plan and section views of pumping stations (wet wells, valve vaults, etc.) to scale. An exception to showing the entire wet well to scale in section views shall be granted for deep wet wells.
5. Where construction will be located in public rights-of-way or connected to existing CFPUA utilities, engineered designs shall be supported by special investigations such as geotechnical reports, subsurface utility locations, property surveys, etc. to reduce potential risk to the public from the resulting work activities.
6. Reference Standards cited below are available on the CFPUA Engineering web page:
 - a. CFPUA Development Process & Procedures Manual
 - b. CFPUA Standard Technical Specifications
 - c. CFPUA Materials Standards Manual (MSM)
 - d. CFPUA Standard Construction Details

II. WATER FACILITIES DESIGN CRITERIA

A. Water Distribution

1. NC DEQ-DWR Public Water Supply Rules
 - a. North Carolina Administrative Code Title 15A Department of Environmental Quality Subchapter 18C Sections .0100 through .2200, Rules Governing Water Systems, contains the rules and regulations applicable to public water systems for the State of North Carolina. North Carolina "Rules Governing Public Water Systems" have adopted state laws and federal regulations by reference, copies of these adoptions are printed into the document after the State Rules.

- b. All water distribution facilities installed under the jurisdiction of CFPUA shall, unless superseded by more restrictive requirements, follow all applicable NC DEQ-DWR Public Water Supply Rules.

2. Pipe Design

a. Size

- Water mains shall be a minimum of 8-inch in diameter, unless otherwise approved by CFPUA. Larger water main sizes will be required when necessary to allow the withdrawal of the required flow while maintaining the minimum residual pressure.
- A 6-inch water main shall only have one (1) fire hydrant unless it is looped.
- Water mains smaller than 6-inch in diameter are permitted on residential cul-de-sacs, hammerheads, and stub streets to reduce water age with approval from CFPUA.
- Water mains not designed for fire flow shall not have any fire hydrants.
- Water lines serving buildings with fire protection sprinkler systems shall be sized to provide adequate pressure for the system per manufacturer's recommendations.
- CFPUA may require the developer to install water mains larger than needed by the immediate development or additional extensions to meet future needs. Public participation in these installations shall be in accordance with the Authority's System Extensions and Cost Recovery Ordinance.
- CFPUA shall have final determination of water main sizing and may require hydraulic and/or water quality modelling
- Hazen and Williams design coefficients shall be $C=120$ for ductile iron pipe and $C=130$ for PVC/HDPE pipe.

b. Design Pressures

- Design all water distribution facilities that will be connected to the CFPUA Water Distribution System for operation of the maximum/minimum Design Pressure range indicated below:
 - Maximum design (test) pressure: 150 psi.
 - Maximum system (operating) pressure: 100 psi.
 - Minimum design pressure at peak hour on max day: 40 psi.
 - Minimum design pressure during fire flow on max day: 20 psi

c. Water Main Extensions

- Where arterial mains must be extended to serve a development, the developer shall extend the mains as directed by CFPUA.
- Water main extensions shall cover the entire frontage of a lot. This can be accomplished by extending the main on either side of the road, or as directed by CFPUA. Corner lots are required to extend the main along the frontage of each road.
- Design mains so they are looped and interconnected at intersections.
- Existing 2-inch diameter water mains or less that were installed using ferrous material shall not be extended to serve additional customers.

d. Depth of cover shall be as follows (regardless of backfill):

- For all pipe material installed by open cut:

- Minimum of thirty (30) inches and maximum of five (5) feet below finished grade.
 - NC DOT right-of-way requires a minimum of thirty-six (36) inches of cover.
 - Depths greater than five (5) feet must be approved by CFPUA.
- Reduced depth of cover to avoid conflicts with storm drains or other utilities shall be considered with CFPUA and Public Water Supply approval: use ductile iron pipe when depth of cover is less than thirty (30) inches, plus an additional length of DIP installed before and after the length of reduced cover. Transition to DIP with DIP MJ sleeves or bends. Clearly shown transitions to DIP on the drawings.
 - Minimum acceptable depth of cover when installing DIP with CFPUA and NC DOT approval: 24 (24) inches.
 - Depth of cover requirements for water mains installed by trenchless methods: as required by the Authority Having Jurisdiction. The depth shall be similar to open cut installation where parcels exist that do not have existing public water service to allow for future water service connections.
- e. Material
- All approved materials for CFPUA water mains and associated appurtenances are specified in the Material Specification Manual.
 - CFPUA retains the right to require ductile iron for any pipe to be installed in the CFPUA service area.
- f. Joint Restraint
- Restraint joints are required to prevent movement of piping caused by forces in or on buried piping, tees, valves, branches, bends, caps, etc.
 - Restraint joints shall be shown on the design plans and record drawings.
- g. Service Taps
- One (1) inch water service shall be installed with Polyethylene (PE) pipe with brass fittings.
 - Two (2) inch water services shall be installed with Polyethylene (PE) pipe with brass fittings.
 - Water services larger than two (2) inches shall be approved by CFPUA prior to installation.
 - Complete service taps (excluding meter only) shall be installed for each existing or proposed residential parcel.
 - For service to existing areas, taps shall be installed to the extent possible according to customer tap cards provided and received by CFPUA.
 - Water meter size shall be sized by Engineer and approved by CFPUA. CFPUA's meter sizing form shall be completed and submitted for approval.
 - Connect and install services perpendicular (at 90-degrees) to the main line. Services shall be installed in a straight line in the horizontal plane with no bends or deflections.

3. Fire Protection

- a. Design systems to provide fire flows and facilities in accordance with the requirements of CFPUA, City of Wilmington Fire Department and New Hanover County where practical. If not practical, confer with Authority Having Jurisdiction in advance of permitting.
- b. Water lines serving fire hydrants shall be eight (8) inches minimum. Six (6) inch water mains shall be approved with fire hydrant(s) provided the design complies with section 3(a).
- c. Larger size mains will be required as necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure as determined by CFPUA.
- d. Design systems to provide for fire flow demands as required by Authorities Having Jurisdiction or 1,000 gpm or whichever is the greater.
- e. Fire protection systems shall be dedicated solely for fire protection and fully segregated from the potable system with no connections for domestic use. Two service taps shall be installed, one for potable domestic water and one for fire protection. The fire protection tap will not be metered by CFPUA for billing purposes. A valve will be installed at the tap and at the right-of-way or easement line denoting the CFPUA owned/privately owned boundary. A privately owned, privately maintained backflow prevention assembly shall be installed per the North Carolina State Building Code and in accordance with the CFPUA Cross Connection and Backflow Prevention Ordinance. The backflow prevention assembly will be of the detector type to allow detection of leakage downstream. The backflow prevention assembly will be installed as close as possible to the CFPUA water main and before the first branch in the water service line. Installation guidance is also found on CFPUA's Backflow Prevention Assembly Installation and Inspection Form.

4. Fire Hydrant Spacing

- a. Spacing shall be directed by the Authority Having Jurisdiction.
- b. Hydrant leads shall be located on the short side of road rights-of-way.
- c. Services shall not be installed on the hydrant lead.
- d. No privately-owned fire hydrants will be permitted to connect directly to CFPUA water mains

5. Interconnection Requirements and Dead Ends

- a. To provide increased reliability of service and reduced head loss, minimize dead ends by looping all mains whenever possible. Match the size of the loop line to the existing lines that are being connected. Confirm if looping provides a system benefit.
- b. Unless approved otherwise by CFPUA, loop all lines serving fifteen (15) residents or more.
- c. A line that dead ends on a cul-de-sac shall follow around the outside of the edge of road and terminate with a blow off valve or hydrant as appropriate.
- d. Looping and valve locations shall be such that an interruption of service due to a water main break will put no more than 800 feet of main or more than two fire hydrants out of service while maintaining adequate flows and pressure in the remaining portion of the system.
- e. The minimum distance for extensions shall not be less than one platted block or completely across the lot frontage, whichever is applicable. It shall not be less than the distance to connect both ends of the extension to existing water mains, when required by the Authority.
- f. Provide dead-end mains with a blow-off for flushing purposes.

- g. Size flushing devices to provide flows which will give a velocity of at least 2.5 feet per second in the water main being flushed. No flushing device shall be directly connected to any wastewater or storm water line.
- h. Provide adequate drainage features that convey water discharged from the flushing device to the storm drainage system.
- i. Provide temporary dead-end main lines which can be extended at a later date with:
 - An in-line valve.
 - And a blow-off for flushing purposes.

6. Valves, Blow-offs, and Sampling Stations

- a. Maximum valve spacing:
 - Eight (8) inch mains: twelve hundred (1,200) feet apart.
 - Twelve (12) inch mains and larger: fifteen hundred (1,500) feet apart.
 - Or, as directed by CFPUA.
- b. Generally, place valves at each street intersection.
- c. Provide a minimum of three (3) valves where four (4) water mains interconnect,
- d. Provide a minimum of two (2) valves where three (3) water mains interconnect,
- e. Blow-offs shall be provided on all dead-end mains.
- f. Sampling stations
 - Provided on all new subdivisions where water mains are installed. The sampling station shall be installed within 100 feet of where the connection to the existing system occurs or per CFPUA specified locations. If the system is looped, then there shall be a sampling station at each end.
 - For main extensions that result in dead ends, a sampling station shall be provided within five (5) parcels to the point of connection or per CFPUA specified locations.
 - Sampling stations shall not be placed directly at dead ends.

7. Cross Connection and Backflow Prevention

- a. A “Backflow Prevention Assembly Installation and Inspection Form” must be submitted to CFPUA’s Community Compliance Section for the installation, relocation, or replacement of backflow prevention assemblies. This form can be found on the CFPUA website and is separate from a New Hanover County Plumbing Permit.
- b. Containment backflow prevention is required on the service line for the following:
 - on all construction sites.
 - on all commercial facilities.
 - on all multi-family dwellings that have shared plumbing.
 - on all premises 5 stories or more.
 - on all irrigation systems, including single-family residences.
 - on all fire services.
 - on all funeral homes and crematories.
 - on all medical facilities.
 - on all schools and colleges.

- on all commercial and residential swimming pools.
 - on connections with a water meter greater than one inch.
 - on water mains served by the Authority but not maintained by the Authority.
 - at locations identified by the Authority to have potential for backflow.
 - Specifics, such as types of backflow protection required, can be found in CFPUA's Cross Connection and Backflow Prevention Ordinance.
- c. Install backflow detector assemblies on fire lines. Install reduced pressure detector assemblies (RPDA) on fire lines with private fire hydrants, booster pumps, foam, antifreeze solution, and buildings with 5 or more stores. Install double check detector assemblies (DCDA) on non-health hazard fire lines, criteria that does not meet RPDA requirements.
 - d. Isolation backflow prevention is not required by the Authority but is recommended.
 - e. Backflow prevention assemblies required by another agency shall also conform to these guidelines.
 - f. When required by the North Carolina Building Code and the NC DEQ-DWR – Public Water Supply Section, make all new construction plans and specifications available to CFPUA's Community Compliance Section for review and approval, and to determine the degree of hazard.
 - g. Install the type of assembly appropriate for the hazard identified by CFPUA's Community Compliance Section. Only install assemblies approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCCHR) or the American Society of Sanitary Engineering (ASSE).
 - h. Prior approval is required from CFPUA's Community Compliance Section for installation of double check valve assemblies in a vertical position.
 - i. Install reduced pressure principle assemblies in a horizontal position and in a location in which no portion of the assembly can become submerged in any substance under any circumstances (pit and/or below grade installations are prohibited).
 - j. Make provisions for a parallel installation of backflow prevention assemblies when it is not possible to interrupt water service for testing, repair, or replacement. The parallel assembly shall be the same type as on the main line. CFPUA will not accept an unprotected bypass around a backflow prevention assembly.
 - k. Install containment backflow prevention assemblies as close to the water meter as possible and before the first branch in the water service.
 - l. Install backflow prevention assemblies on the supply side (suction side) of pumps a minimum length upstream of the pump of 10 feet or one foot per inch of pipe diameter, whichever is greater.
 - m. Provide minimum clearance of 12 inches on all sides of interior-installed backflow preventer.
 - n. Install backflow prevention assemblies at least 12 inches above the finish grade, flood level, or floor elevation, as measured from:
 - Double check valve (DCVA): from the bottom of the assembly.
 - Reduced pressure principle (RP): from the bottom of the relief discharge port.
 - o. Install backflow prevention assemblies no higher than 60 inches above finished floor.
 - p. Install exterior backflow prevention assemblies inside a protective enclosure design to protect the assembly from theft, vandalism, tampering, weather, and frost.
 - q. In the floor, underground, and vault installations are prohibited.

- r. Do not install backflow prevention assemblies above electrical equipment, outlets, and breaker boxes.
- s. Contact CFPUA's Community Compliance Section for additional information prior to installing assemblies indoors.
- t. Backflow prevention assembly inspection and testing:
 - Inspections: An initial inspection from CFPUA is required before a meter can be set.
 - Testing: Testing by an approved tester is required within 30 days of the water meter being activated and annually thereafter.

8. Irrigation Services

- a. Water dedicated solely for irrigation service may not be used for potable, domestic or any other use.
- b. Separate meters for new, in-ground irrigation systems are required on lots platted and recorded in the office of the Register of Deeds in New Hanover County after July 1, 2009.
- c. Irrigation meters shall be sized by Engineer and/or Landscaper utilizing CFPUA's meter sizing form and submitted to CFPUA for approval.
- d. Residential domestic services must be split for an irrigation service by a Licensed Utility Contractor prior to the Close-Out Inspection.
- e. Commercial development shall have separate domestic and irrigation services tapped off of the main line.

9. Water Facilities Identification

- a. Potable water mains color code: per Material Specification Manual
- b. Detection tape: provide an electronically or magnetically detectable tape for water mains that are installed by the open-trench method, regardless of piping material.
- c. Tape design life: equal to the life of the pipe that it is installed over, even in adverse soils.
- d. Tracer wire: provide for all water main installations, regardless of piping material. Verify tracer wire functionality prior to final acceptance.
- e. Refer to 33 01 12 - Identification of Utilities Piping for specifics.

10. Connections to Existing Water Facilities

- a. Subject to CFPUA approval connections made to a water main can be size-on-size but cannot be larger than the main being tapped if the water main being tapped is a part of a looped water distribution system.
- b. If the water main is not part of a looped water distribution system, the tap shall be a minimum of one size smaller than the water main being tapped.
- c. If the tap size required is the same size as the main being tapped, a MJ tee will be required.
- d. Service saddle taps larger than two (2) inches will not be allowed.
- e. CFPUA reserves the right to stipulate the maximum size tap available off any water main regardless of the main size and configuration, if it is deemed in CFPUA's best interest to do so.

- f. Service taps are not allowed on any transmission main unless otherwise approved by CFPUA. All water mains larger than sixteen (16) inches in diameter are considered transmission mains.

III. WASTEWATER FACILITIES DESIGN CRITERIA

A. Collection and Force Main Systems

1. NC-DEQ Minimum Design Criteria

- a. North Carolina Administrative Code Title 15A Department of Environmental Quality Subchapter 2T .0300, Waste Not Discharged to Surface Waters contains the rules and regulations applicable to the extension of gravity sewers, force mains and wastewater pumping stations.
- b. Further, minimum design criteria for gravity sewers and force mains and wastewater pumping stations are provided in Minimum Design Criteria for Permitting Gravity Sewers and Minimum Design Criteria for Permitting Pumping Stations and Force Mains. As implied by the titles of these documents, the design criteria are minimum in nature only and present baseline, fundamental design, and construction requirements necessary for gravity sewers, pumping stations and force main systems.

2. Gravity Mains

- a. Size sewer collection and gravity outfall lines based on the ultimate size of the area to be serviced and by the projected use and population of the area.
- b. Gravity sewer shall be designed so that when the basin is built out, it flows half-full at average day and does not surcharge during peak flow. Gravity sewers with existing flow that exceeds either of these parameters will be considered out of capacity without Authority approval based on planned rehabilitation to reduce I/I, planned flow diversion to another basin, or other mitigating factors.
- c. Minimum gravity main line size for public sewer mains shall be 8-inches. Minimum gravity main line size for private sewer mains shall be 6-inches.
- d. Gravity mains shall have straight alignment and uniform slope between manholes.
- e. Depth shall be adequate to receive wastewater from the lowest service by gravity flow.
- f. Gravity sewer shall generally be designed with the invert no deeper than 12 feet below the ground surface and never deeper than can be safely installed and maintained with two stacked 8-foot trench boxes without Authority approval prior to design.
- g. Where two or more mains of different diameters enter a manhole, match crown elevation of outgoing pipe.
- h. Each Development is responsible for construction of gravity sewer to the depth necessary to serve the development. The Authority may require the installation of deeper gravity sewer so that it can be extended to serve outside of the development in the future. The Developer may request cost reimbursement for the difference in construction cost to install this deeper gravity sewer. The difference can be calculated by using the most recent version of RS Means Cost Estimating Data or the Developer can design and bid the project at both gravity sewer depths to establish the difference in cost that may be reimbursed

under an agreement with the Authority. Public participation in these installations shall be in accordance with the Authority's System Extensions and Cost Recovery Ordinance.

- i. Sewer collection and outfall mains shall be tested and inspected to determine the accuracy of alignment and grade.
- j. The allowable amount of infiltration is 0 (zero) gallons per diameter inch per mile per day.
- k. Gravity Sewer Main Extensions
 - Where gravity sewer mains must be extended to serve a development, the developer shall extend the sewer mains as directed by CFPUA.
 - Sewer main extensions shall be as necessary to serve the development. Sewer depth and location shall provide the capability for interconnecting gravity sewer service beyond the development, if applicable. Appropriate easements shall be provided.

3. Force Mains

- a. Size force mains to meet the demand requirements of the service area and capacity of the pump station but shall not be less than four (4) inches in diameter.
- b. Design velocity shall be a minimum two (2) feet per second scouring velocity.
- c. Under all flow conditions a maximum velocity below eight (8) feet per second is required.
- d. Maximum pipe size shall be to maintain minimum scouring velocity and minimum pump discharge head.
- e. Hazen and Williams design coefficient shall be for new pipe and aged material per the MDC. Both new and aged conditions shall be submitted.
- f. Locate force mains as directed or approved by CFPUA.
- g. Provide a minimum of three (3) feet of cover and maximum of five (5) feet of cover.
- h. Design force mains integral with the pumping units and system head curves.
- i. As directed by CFPUA, provisions for bypass pumping shall be provided for, but not necessarily limited to, the follow:
 - Bypass for normal construction/repairs.
 - Bypass for incident action during emergency events.
 - Parallel force mains for future growth or high consequence of failure.
- j. Provide eccentric plug valves, meeting the requirements of the CFPUA Materials Specifications Manual, inside pump station valve vaults.
- k. Provide resilient seat gate valves, meeting the requirements of the CFPUA Materials Specifications Manual, for in-line buried service.
- l. Provide Air Valves (Air Release, Air/Vacuum, or combination Air Valves), meeting the requirements of the CFPUA Materials Specifications Manual, to allow the unrestricted venting or reentry of air during filling or draining of the force main and release of accumulated air during operation. Select, size, locate, and install air valves in accordance with AWWA Manual of Practice M51 Air Valves: Air Release, Air/Vacuum, and Combination.
- m. Provide a plot of Hydraulic Grade Line (HGL), ground surface elevation and force main profile along the length of the force main to CFPUA for review and comment.
- n. Pressure test force mains at a minimum test pressure of 150 psi for a minimum of two (2) hours in accordance with CFPUA standard specification.

- o. Restraint joints are required to prevent movement of system piping caused by forces in or on buried piping, tees, valves, branches, bends, plugs, etc.
- p. Restraint joints shall be shown on the design plans and record drawings.

4. Service Connections

- a. Minimum service connection size shall be as follows:
 - Single family residence: 4-inch.
 - Commercial, multi-family, and non-residential: 6-inch.
- b. Commercial, multi-family, and non-residential units shall have services designed by an engineer.
- c. 8-inch and larger service lines shall connect to a manhole only.
- d. Service lines shall be PVC pipe, or ductile iron as directed by CFPUA, with a clean out box. Location of the cleanout shall be in accordance with CFPUA standard detail, unless otherwise approved by CFPUA.
- e. Complete service connections shall be installed for each existing or proposed parcel. For service to existing areas, service connections shall be installed according to customer tap cards provided and received by CFPUA. Otherwise locate sewer service as approved by CFPUA.
- f. Connect and install services perpendicular (at 90-degrees) to the main line, except when a manhole connection is allowed. Services shall be installed in a straight line in the horizontal plane with no bends or deflections.
- g. Tracer wire shall be installed on all sewer service connections from the main line wye to the clean-out box and extend above grade per CFPUA Detail S-9/S-10.

5. Manholes

- a. Install manholes at optimum intervals of three hundred (300) feet and maximum intervals of four hundred and twenty-five (425) feet along straight sections of sewer lines.
- b. Install manholes at all breaks in grade, changes in pipe size, changes in direction of flow, and at all sewer line intersections except service connections.
- c. Determine manhole diameter by the depth of cut, diameter of pipe, angle of convergence of the intersecting pipes, and the size of entering drop pipes.
- d. Minimum manhole diameter shall be four (4) feet for depths up to 12 feet.
 - Larger inside diameters may be required if future inside drop connections are likely.
- e. Minimum manhole diameter shall be five (5) feet for depths greater than 12 feet or for inside drop connections, if approved by CFPUA.
 - Larger inside diameters will be required for larger pipe sizes, more than two pipes, or when entrance and exit angles.
- f. Minimal angle between sewer mains intersecting at manhole shall be 90-degrees or greater measured from the downstream side.
- g. Manhole top elevations shall be at or above finished grade or set to match finished pavement grade, if located in paved areas.
- h. Use water-tight ring and cover in flood plain areas or areas subject to flooding.
- i. Use vented manholes as requires by NCDEQ.

- j. Coat manholes in accordance with CFPUA's specifications when manhole will receive force main discharges, when manhole is the first manhole upstream of a pump station's wet well, and elsewhere as required. Polymer concrete manhole inserts may be required as directed by CFPUA. These inserts shall be provided with a minimum 50-year warranty.
- k. Provide drip pans. Use stainless steel in traffic bearing areas.
- l. Provide a minimum of six (6) inches of separation between edge of manhole core holes and manhole barrel joints. Provide a minimum of six (6) inches of separation between edges of core holes. Coring the manhole cone section is not allowed.
- m. Provide special design details for each location where new manholes are constructed in existing sewer mains.

6. Grease Traps/Interceptors

- a. Shall be approved by the CFPUA's Community Compliance Section. The application for authorization to construct shall be signed by the owner, proprietor, or responsible official, and include:
 - Contact information for the owner, proprietor, or responsible official.
 - Address of the facility.
 - A drawing showing the location of the building, kitchen, interceptor, and traffic ways.
 - The manufacturer's model number and specifications.
 - A list of all plumbing fixtures plumbed to the interceptor including the drainage fixtures units (DFU) and trap size of each fixture.
- b. Shall be in-ground, exterior installation, and readily accessible for unhindered maintenance and inspection.
- c. Shall be sized to achieve a minimum 20-minute detention-time. Interceptor volume required to achieve 20-minute detention-time is calculated by: $V=Q \times 20$
 - V is the required wetted volume of interceptor in gallons
 - Q is theoretical flow rate into the interceptor in gallons per minute (gpm). The theoretical flow rate is determined by summing the DFUs, as specified in the International Plumbing Code (IPC), of all fixtures plumbed to the interceptor and converting to gpm (2 DFU = 1 gpm). For automatic dishwashers and similar fixtures, the manufacturer's discharge flow rating may be used.
- d. Shall have inlet and outlet tees. The inlet tee shall be sized to match the service (a minimum of 3 inches in diameter) and the length shall extend 25% (20% to 30% allowed) into the liquid depth. The outlet tee shall be 6 inches in diameter and the length shall extend 50% (45% to 55% allowed) into the liquid depth.
- e. Shall have a means to slow the flow to avoid short-circuiting, such as a baffle system and dual sweep tee.
- f. Shall have at least 9 inches of freeboard above the liquid surface.
- g. Shall have access openings over the inlet, outlet, and each compartment within the grease interceptor. Each opening shall be twenty-four (24) inches in diameter and contain pick holes. Shall be storm water infiltration proof. Manholes or covers shall extend to the finished grade.
- h. Shall be designed to handle traffic-bearing loads when located in vehicular travel ways. Interceptors in non-vehicular areas shall be at least pedestrian load bearing.

- i. Shall be vented in accordance with the IPC as adopted by North Carolina.
- j. Plumbing fixtures connected to the interceptor shall have baskets, screens, or other intercepting devices to prevent passage into the drainage system of solids ½ inch or larger in size. The baskets, screens, or devices shall be removable for cleaning purposes.
- k. Waste from food grinders shall discharge through a solids interceptor prior to entering the grease interceptor. All other fixtures and drains (except those not exposed to grease laden sources) receiving kitchen or food preparation wastewater shall pass through the grease interceptor.
- l. Interceptors that are cast-in-place, masonry tanks, or not a manufactured grease interceptor shall be designed by a professional engineer licensed by North Carolina.
- m. Construct grease interceptor of impervious materials capable of withstanding abrupt and extreme changes in temperatures and shall be of substantial construction, watertight.
- n. Properly seal joints to prevent infiltration or leakage using mastic, butyl rubber, or other pliable sealant that is waterproof and corrosion resistant.
- o. Provide minimum three-inch (3") thick 3,500 psi concrete compressive strength walls reinforced with 6 x 6 #10-gauge welded wire.
- p. A proposed nonconventional interceptor may be evaluated and approved on a case-by-case basis contingent upon proper sizing and documentation demonstrating grease removal efficiencies are equivalent to a conventional interceptor.
- q. A request to install an interior interceptor, interior trap or automatic grease removal devices shall include a design plan certified by a professional architect, engineer, or plumber, licensed by North Carolina, demonstrating that there is inadequate space for exterior installation. Inadequate space considerations include legal property boundary restrictions, utility conflicts that cannot be relocated, proximity to the building and its foundation, or overhead obstacles.

7. Pipe Identification and Detection

- a. Gravity sewer mains color code: per Material Specification Manual
- b. Force mains color code: per Material Specification Manual
- c. Detection tape: provide an electronically or magnetically detectable tape for wastewater mains that are installed by the open-trench method, regardless of piping material.
- d. Tape design life: equal to the life of the pipe that it is installed over, even in adverse soils.
- e. Tracer wire – sewer services; provide for all sewer service installations, regardless of pipe material.
- f. Tracer wire – force mains: provide for all wastewater force main installations, regardless of piping material.
- g. Refer to 33 01 12 Identification of Utilities Piping for specifics.

8. Connections to Existing System

- a. All connections to existing CFPWA manholes or collection systems must be made in the presence of an CFPWA Inspector.
- b. Cut-in manholes are required at connections to existing gravity lines. Manholes constructed over existing gravity lines (dog-house manholes) are not allowed.
- c. Core drill all new holes into existing manholes. Seal cored hole with a rubber gasket and/or link seal.

- d. No wastewater line of any type shall be allowed to pass through any storm drainage structure without prior approval of CFPUA.
- e. A minimum of five (5) feet of gravity main shall be replaced on existing vitrified clay pipe (VCP) gravity mains, centered on proposed connections. This shall be shown on the design drawings. A new manhole installation shall require a minimum of ten (10) feet of gravity main replaced on each side of the new manhole.
- f. Where new gravity sewer mains or new force mains connect to existing CFPUA infrastructure, the design engineer shall perform appropriate hydraulic calculations that confirm that the receiving infrastructure has adequate capacity for the additional flow. Adequate capacity shall be as defined by the State's applicable Minimum Design Criteria.

B. Pumping Stations

1. General

- a. Design pump stations to be fully operational during flooding to the one hundred (100) year flood elevation.
- b. Design pump station structures and equipment to be protected from physical damage by flooding to the one hundred (100) year flood elevation.
- c. Provide a Pump Station Emergency Operation Plan. For areas determined to be environmentally sensitive (e.g., shellfish harvesting areas, designated recreational waters, or primary source water protection areas located in close proximity), more extensive plans and equipment will be required, including on site auxiliary power or an approved equivalent plan. The effect of power outages where the pump station serves sources such as businesses that would not be able to operate otherwise will also be evaluated.
- d. Include the following, subject to approval by CFPUA, to provide continuous operability in the event of a power failure, natural disaster, etc.:
 - Provide an on-site standby generator with automatic transfer switching and a double throw safety switch that has been provided to accommodate the connection of a portable generator.
 - All stations – Install permanent emergency bypass piping connections to the force main. Connections to be approved by CFPUA.
- e. Provide an audible and visible high-water alarm system and SCADA System per CFPUA standards to notify remote staff. Design alarm system to function if power is not available to the pump station.
- f. Provide potable water sampling station when water is available.
- g. Pump station designs shall include a minimum of two on-site soil borings. A soil boring shall be performed in locations where proposed structures are to be installed. Structures for soil boring consideration shall include wet well, head works, and slab on grade that is expected to carry a large load.

2. Design Flows

- a. Provide calculations for the average design flow and flow peaking factor.

3. System Curve and Pump Design/Selection

- a. Submit system curve calculations and a plot of System Flow versus System Head to CFPUA for review and comment. Include appropriate system information; static head, force main length and size and roughness coefficient assumptions, meters, valves, and fittings, used in the system curve calculations.
- b. Proceed with pump selection when CFPUA has accepted the calculated system curve.
- c. Select pumps to:
 - Provide a firm pumping station capacity equal to peak flow conditions.
 - Operate in the pump's Preferred Operating Region (POR).
 - Maximize the pump operating efficiency. Pumps greater than 25 HP shall have a minimum efficiency of 70%.
 - Motor shall maintain a minimum efficiency of 90%.
- d. The firm pumping station capacity is the capacity with the largest pumping unit out of service. For duplex pumping stations each pump capacity is equal to peak flow.
- e. The pump's POR is defined in ANSI/HI 9.6.3 as a range of flow to either side of the Best Efficiency Point (BEP) within which the pump's hydraulic efficiency is not substantially degraded. Generally, the POR is between 70% to 120% of BEP. Provide confirmation from the pump manufacturer of the actual POR.
- f. By selecting pumps to operate inside of POR the pump life and reliability will be maximized, and energy consumption will be minimized.
- g. Submit required Net Positive Suction Head (NPSH) calculations to CFPUA for review and comment.
- h. Submit a plot of Pump Flow versus Pump Head combined with the plot of System Flow versus System Head to CFPUA for review and comment. Include appropriate pump data; shutoff head, pump efficiency and BEP, pump POR limits, NPSH required and NPSH available.
- i. Pump selection must be approved by CFPUA.
- j. An additional (spare) pump shall be provided. In cases where the identical pump and impeller is already available to be used as a spare, a variance for providing a spare pump shall be requested. Written authorization from CFPUA staff must be provided at the time of inspection if a spare pump will not be provided.
- k. Velocity in all piping in a pump station and all force mains shall be under 8 fps. In a force main manifolded with other pump stations, the minimum velocity the proposed pump station shall maintain while all other pump stations are operating shall be 2 fps.
- l. A hydraulic analysis of a pump station shall be done per policy ENG-002, New Development Modeling Policy and Procedure. The analysis shall review how the proposed system operates alone as well as the impacts on the pump stations that manifold into the shared force main.

4. Wet Well

- a. General
 - Design the wet well to provide uniform, steady flow free of swirl and entrained air into the pump. Follow the recommendations and requirements published in ANSI/HI 9.8

Rotodynamic Pumps for Pump Intake Design and the pump manufacturer's requirements.

- Submit information from the proposed pump manufacturer that the pump design has adequate submergence for operation.
- Submit wet well flotation calculations, based on an empty wet well and the ground water table at proposed finished grade, to CFPUA for review and approval.
- Vent the wet well with a minimum four (4) inch diameter pipe as indicated on the CFPUA Standard Construction Details.
- Set wet well top elevation a minimum of two (2) feet above the FEMA 100-year flood elevation for the site. Provide flood proof hatches in situations where the wet well top slabs elevation cannot be set a minimum of two (2) feet above the FEMA 100-year flood elevation. In all cases, set the wet well vent a minimum of two (2) feet above the FEMA 100-year flood elevation.
- Design a single pipe inlet into the wet well. Collect multiple pipes entering the site into a manhole upstream of the wet well. Design pipe inlet into wet well to minimize aeration and turbulence.
- Line wet wells in accordance with construction specifications and material specification manual.
- Protect all exposed surfaces and structures, including walls and underside of top slab, riser piping, and metallic influent piping inside wet well, from corrosion.
- Submit geotechnical report with soil boring(s) for proposed wet well location.

b. Minimum Wet Well Volume

The minimum required wet well volume is determined by satisfying the following under Average Design Flow (ADF) conditions:

- Provide the greater of; adequate pump submergence or the required NPSH.
- Provide working volume (the volume between pump on/off elevations) sufficient to limit the number of pump on/off cycles to between two (2) and eight (8) per hour, or fewer as required by the pump manufacturer.
- Provide for alarm level settings.

c. Depth Based on Control Elevations

The depth of the wet well shall be set to accommodate the following level control system parameters, or as otherwise directed by CFPUA:

- "Lead Pump Off"
- "Lead Pump On"
- "Lag Pump On"
- "High Water Telemetry"
- "High Water Alarm"

5. Flow Metering

- a. Meter wastewater flow with a magnetic flow meter meeting the requirements of the CFPUA Standard Technical Specification Section 40 71 00 - Magnetic Flow Meter.
- b. Meter shall provide a minimum fluid velocity of 2 feet per second.

- c. Install meter in accordance with manufacturer's recommendations including required upstream and downstream straight run of piping.
- d. Install flow meter in a concrete meter vault or combined with the valve vault as directed and/or approved by CFPUA.

6. Site Considerations

- a. Pump station site criteria:
 - Minimum site dimensions: 50' x 50' square in size. Larger sites may be required based on the pump station capacity, features, odor control systems, site orientation, etc.
 - The site and access drive shall maintain a level surface with a less than 2% slope to allow for natural drainage. All structures and vaults, including foundations, wet well tops, and manholes shall have the same elevations.
 - Front on an all-weather publicly maintained roadway or having approved alternate access.
 - Signage: Weather-durable sign with name of pump station and a twenty-four (24) hour emergency telephone number. Mount at a conspicuous point on the fence.
 - Access control: provide site perimeter fence. Decorative fencing is required for all pump stations in residential neighborhoods and other highly visible areas, as directed by CFPUA.
- b. Refer to CFPUA Standard Construction Details for the pump station site features.
- c. Set utility power pole outside the fenced area in a manner so the electric meter can be easily read from outside the fenced area. Run all on-site power lines underground.
- d. Provide adequate exterior area lighting for the interior of the fenced area. Provide adequate task lighting for safe and efficient night-time maintenance/operational activities. Provide a switched separate circuit for exterior area lighting at the control panel. Provide switches for individual task lighting areas.
- e. Supply water to pumping station site through a reduced pressure (RP) backflow preventer installed inside the fence. At a minimum provide a one (1) inch non-freeze yard hydrant.
- f. Landscaping plans for the pump station site must be approved by CFPUA.

7. Odor Control

- a. At CFPUA's direction provide an odor control system. Type and design of an odor control system is to be addressed on a case-by-case basis.
- b. At CFPUA's direction reserve a 15-foot square footprint on the site for a future odor control system.

8. Electrical

- a. Provide all OSHA signage to include confined space entry, ARC flash, flammable fuels, etc. ARC flash study should be completed.
- b. Provide NEMA 4X stainless steel enclosures. Protect enclosures from the wet well atmosphere by an air gap of 66" minimum as indicated in the standard details.
- c. Design enclosures to facilitate lock-out/tag-out procedures.
- d. Unless otherwise regulated, provide only braided or stranded wire. Minimum conduit size allowed is one (1) inch in diameter.

- e. Provide aluminum conduits installed in exposed areas. Provide PVC conduits installed underground or encased in concrete. Transition from concrete encased PVC to aluminum inside the concrete encasement. Coat the portion of aluminum conduit inside the encasement with asphaltic urethane paint.
- f. For submersible stations, provide a separate 3-inch diameter conduit for each pump lead. Provide duct-seal to isolate sewer gases from the control panels.
- g. Three-phase power is preferred. If installation of three-phase power is not feasible, variable frequency drives may be installed as an alternative with CFPWA approval.

9. Protection of Electrical Panels and Controls

CFPWA has two basic scenarios for protecting electrical and control panels at its typical submersible pump station sites. For new or upgraded pumping stations, the scenario will be determined by CFPWA generally based on capacity and siting constraints. General guidelines are shown below. For additional information, refer to CFPWA Standard Construction Details and specifications.

- a. Enclosed structures (control building) are required and shall be one of the following types:
 - Prefabricated, precast concrete enclosed structures are available in standard or custom sizes and useful for station sizes 25 horsepower and larger. An HVAC system is typically required for the enclosure.
 - Custom built masonry and frame construction enclosed structures are custom sized and typically used at stations larger than 100 horsepower. An HVAC system is provided for the enclosure.
- b. Enclosed structure exception: This scenario becomes necessary for existing pumping station upgrades with site constraints. The following situations can occur under the no enclosed structure scenario:
 - A sun/rain hood constructed of 316 stainless steel is preferred to shield the required NEMA 4X, 316 stainless steel panels.
 - When extreme site limitations exist only NEMA 4X, 316 stainless steel panels are required.

10. Instrumentation and Controls

- a. General:
 - Provide an instrumentation system to allow remote monitoring an of the pumping station. Remote monitoring status is communicated with the central SCADA system via the CFPWA's radio telemetry system.
 - All switches, pilot lights, control devices, major components and pumps shall be clearly labeled according to function with engraved plastic plates, including pump identification, manufacturer, model, horsepower and impeller size.
- b. Instrumentation:

Provide the following minimum instrumentation at each pumping station:

 - Wet well Level Measurement by Ultrasonic Level Technology.

- Pump Lead, Lag, Off control via float switches.
 - Backup level control and monitoring via float switches (High and Low level, High Alarm)
 - Pumping Station Discharge Flow via Magnetic Flowmeter
 - Force Main Pressure Sensor and Gauge
 - Intrusion Switches for equipment enclosure or building, and SCADA Panel
- c. Power Distribution:
- See Division 26 of CFPUA Standard Technical Specifications for description of electrical feed to panels. Include a portable generator connection receptacle and associated breaker/disconnect to connect generator power and disconnect normal power in the Motor Starter. Provide a Phase/Voltage monitor and lightning arrester on the main power distribution lines in the pump control panel.
 - Provide a suitably sized control power transformer to supply 115 VAC control power to loads as indicated in the standard electrical details.
- d. Single Speed Pumps - Motor Starters:
- Motor Starters: NEMA type starters, heavy duty industrial design with electronic overload protection.
- e. Single Speed Pumps - Soft Starts:
- Motors rated at 20 HP or larger: Provide Soft Start Motor Controllers with automatic bypass contactor function.
- f. Variable Speed Pumps – Adjustable Frequency Drives (AFD):
- Variable speed pumping will be evaluated for all major stations and for smaller stations that discharge to manifolded force mains or have direct influence on treatment plant operations. Evaluations will compare the additional capital and maintenance cost of AFD's energy saving benefits and operating control benefits. AFD's should include maintenance bypass contactors.
 - Provide air-conditioned enclosures and maintenance bypass contactors for AFD applications.
- g. Miscellaneous Components:
- Refer to Division 26 of CFPUA Standard Technical Specifications for additional guidance on miscellaneous panel equipment, such as switches, terminal strips, relays, etc.

11. Control Overview

- a. Standard Duplex Pump Station (Fixed Speed Pumps):
- Primary Control: Float based control with pump alternation to equalize run times.
 - Backup Control: High and Low alarm floats. When the High-Water level alarm float is activated, both pumps are started. The pumps will continue to run until the Low-Level float is activated.
 - When the High-Water Alarm float is activated, the local audible and visible alarm will be activated.
 - Secondary level system can be requested to be incorporated into controls.

- b. Standard Triplex Pump Station (Variable Speed Pumps):
- Primary Control: PLC based control, running a wet well level control algorithm with lead/lag capability. Incorporate runtime accumulation and pump alternation into the lead/lag algorithm to equalize run times of all three pumps.
 - Start lead pump at minimum speed when the wet well level exceeds the wet well Operating Level setpoint and adjust the speed to control wet well level. Start the lag pump when the lead pump reaches 100% speed and the wet well level reaches the lag pump call setpoint and adjust the speed of both pumps to control wet well level.
 - The lead and lag pumps will ramp to match speed output to control wet well level.
 - Provide operator adjustable setpoints for: Wet well Operating Level, Lead and Lag pump start and stop setpoints. Configure the operator adjustable setpoint to be adjusted from the Operator Interface Terminal or from the SCADA system.
 - Backup Control: High and Low alarm floats. Override PLC control and start two pumps at a preset speed when the High-Water Level alarm float is activated. Stop the pumps when the Low-Level float is activated.
 - Activate the local audible and visible alarm when the High-Water level alarm float is activated.
 - Incorporate an automatic pump station drawdown test program into the PLC programming.
 - Configure the PLC program to provide a periodic wet well cleaning cycle by running the pumps at full speed to preset low wet well setpoint. Configure the PLC program for the duration of and time interval between cleaning cycles to be operator adjustable.

C. Low Pressure Sewer Systems

1. General

Low pressure sewer systems, including grinder pump stations, shall be designed in accordance with CFPUA standards and applicable state and local standards.

2. Commercial Grinder Pump Stations

- a. Commercial and industrial grinder pump stations shall be privately permitted in the Owner's name and shall be operated and maintained by the Owner.
- b. Pump stations shall be duplex stations. Semi-positive displacement grinder pumps are required when making a connection to a high-pressure force main.
- c. Private stations shall meet the criteria of CFPUA's Technical Specifications.
- d. The Engineer shall model the system and select a pump with the appropriate discharge head conditions to operate satisfactorily under all operating conditions.

3. Residential Grinder Pump Stations

- a. Residential grinder pumps connected to low pressure system mains shall be operated and maintained by CFPUA.
- b. Residential grinder pumps connected to gravity sewer permitted under the Building Code may be privately owned or may be operated and maintained by CFPUA.

- c. Simplex low-pressure grinder pumps shall be Barnes OGP 2 HP or approved equal.
- d. The low-pressure system shall be kept in operation at all times. Where connections are made to existing mains, arrangements must be made with CFPUA to ensure continued operation.
- e. Wet well shall have a minimum storage capacity of 360 gallons above the Pump Off level.
- f. Pump stations shall include a backup battery, high-level alarm, and a generator inlet matching CFPUA's portable generator connector.

4. Force Mains

- a. Size force mains to meet the demand requirements of the service area and capacity of the pump station but shall not be less than two (2) inches in diameter.
- b. Locate force mains as directed or approved by CFPUA.
- c. Provide a minimum of three (3) feet of cover and maximum of five (5) feet of cover.
- d. Design force mains integral with the pumping units and system head curves.
- e. Provide valves, meeting the requirements of the CFPUA Materials Specifications Manual, inside pump station and valve vaults.
- f. Low pressure force main extensions shall cover the entire frontage of the lot. This can be accomplished by extending the main along either side of the road, or as directed by CFPUA. Corner lots are expected to extend the main along the frontage of each road, or as directed by CFPUA.
- g. All low-pressure sewer main connections shall be made at a manhole and enter at a minimum of crown to crown of the largest diameter piping. If the connection is made within 30-inches of the invert, a slide shall be installed. Connections made greater than 30-inches from the invert require an inside drop. If a connection is made to an existing or new manhole, the manhole shall be lined per Section 33 05 13 - Precast Concrete Manholes and Utility Structures.
- h. Shut off valves shall be installed every ten consecutive service connections or every one-thousand (1,000) feet of main line, whichever is least, and on both ends of directional drills unless otherwise directed by the Engineer or CFPUA.