
WATER & SEWER DESIGN

(Last revised 7/24/06)

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USEFUL REFERENCES (Hyperlinks)

[NC Department of Insurance, NC State Building Codes On-Line](#) (Link to their web site)
[City of Jacksonville Cross Connection Control Policy](#)

1.1 GENERAL

1.1.1 SPECIFICATION AND DESIGN MANUAL:

- A. All projects within the jurisdiction of the City of Jacksonville shall be designed and constructed in accordance with the City of Jacksonville's Manual of Specifications and Standards, latest revision.
- B. Public sanitary sewer gravity mains, force mains, and lift stations shall conform to the design and construction requirements of the NC Department of Environment and Natural Resources, Division of Water Quality, NCAC Title 15A 2H .0200 *Waste not Discharged to Surface Waters*, latest revision.
- C. Public water distribution systems shall conform to the design and construction requirements of the NC Department of Environment and Natural Resources, NCAC Title 15A, Subchapter 18C, *Rules Governing Public Water Systems*, latest revision.
- D. All structures and utilities shall comply with the applicable Areas of Environmental Concern (AEC) Standards, as amended, in accordance with the State Guidelines for AEC's (15 NCAC 7H) pursuant to the Coastal Area Management Act of 1974.

1.1.2 PERMITS:

- A. **Plan approvals, Water & Sewer Permits:** Prior to commencing construction, all plan approvals and water and/or sewer permits shall be obtained. A preconstruction conference with the City Inspector must also be held at City Hall prior to commencing any construction.
- B. **Encroachment Permits:** An encroachment permit will be required from any Contractor or Developer wishing to excavate or place utilities on NCDOT or public right-of-ways.
- C. **Pavement Cuts:** Pavement cuts in streets shall be repaired in accordance with the specific requirements of public agency on whose street or roadway the utility is being placed, as well as any other applicable requirements dictated in the approved encroachment permit. Open cut or bored crossings shall otherwise adhere, as applicable, to specification section [02275, Trenching, Backfilling & Compaction of Utilities](#).
- D. Developer must obtain all other State and Local permits, as applicable (Air Quality, Erosion and Sedimentation Control, Zoning, etc.)

- 1.1.3 Plan Review and Observation Fees:** All plan review and observation fees must be paid prior to acceptance of project. Refer to the current City fee schedule for applicable fees.

1.2 WATER SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for water system design on systems owned and maintained by the City of Jacksonville.

1.2.1 DISTRIBUTION SYSTEM

- A. **General:** Distribution systems shall generally meet the minimum requirements of the NC Department of Environment and Natural Resources, NCAC Title 15A, Subchapter 18C, *Rules Governing Public Water Systems*, latest revision.
 - 1) **Water Supply System:** The subdivider shall connect the subdivision or development with the water system at his expense, and shall construct it in such a manner as to serve adequately for both domestic use and for fire protection.
 - 2) No new permanent structure or pond shall be constructed over water mains or located within water or sewer easements.
- B. **Fire Demand:** For design purposes, refer to the NC Fire Prevention Code, latest revision. Click on link at top of this document (Web address: <http://www.ncdoi.com/OSFM/Home/Marshal.asp?PARAMSection=sidEngineeringCode&PARAMCategory=cidResidentialBuildingCode>).

C. **Design - System Design:** As part of the design, the Engineer shall model all new systems using **EPAnet, KyPipe, WaterCAD**, or other approved compatible, software. The design data shall include a sketch of the system showing assumed minor losses, pipe roughness (“C” Constants assumed), line lengths, fixed grade node elevations, node numbers, demands, pipe numbers, time of day of field test of hydrant (static pressure converted to elevation head) for verification of starting elevation head, the static water elevation in tank at the time a static pressure reading was taken and, ground elevation of hydrant tested.

1. **Pipeline Velocity:** 3 to 6-fps normal working conditions are preferred although higher velocities in short lengths of pipe may be tolerated for brief periods. Sustained high discharge velocities can scour the pipe’s interior and increase leakage.
2. **Main Size:** Water mains shall be sized in accordance with the City of Jacksonville’s long-range water distribution system plans. Standard main sizes in the City of Jacksonville’s distribution system are 2, 6, 8, 12, 16, 24, and 30 inches. The minimum diameter of public water main is 2 inches.

Fire hydrants shall not be installed on mains less than 6 inches in diameter. Multiple (more than 1) hydrants shall not be installed on less than an 8-inch main.

3. **Looping/Interconnectivity:** Water mains shall be designed to be looped and interconnected as required by City Public Services Director.
4. **Valving:** Valve shall be fully accessible from ground surface by means of a valve box.

a. **Valve type/size:**

- i. **Valves on 2-inch lines and blow off mains:** Mueller Oriseal Mark II curb valve or approved equal.
- ii. **Valves on 6 through 48-inch mains:** Valves 6 inch through 48 inches shall be resilient seat gate valves.
- iii. Butterfly valves are not permitted.
- b. Valves shall be installed at all branches from feeder mains and between mains and hydrants according to the following schedule:
 - i. One 6-inch valve shall be installed on each fire hydrant leg.
 - ii. 3 valves at tees (excluding fire hydrant tees),
 - iii. 4 valves at crosses,
 - iv. An in-line valve shall be installed on the water line and shall not exceed the distances given below:

Line size	Distance
2, 6 or 8-inch mains	450 feet
12-inch mains	1000 feet
16-inch & larger mains	2000 feet

If required, when tapping an existing live main and inserting a main line valve, the main being tapped must be shut off and a valve installed (cut-in) on the existing main within close proximity to the new connection. In lieu of shutting off the existing main and cutting in a valve, the City Public Services Director may allow an “inserting” valve to be placed if the former is undesirable or impractical.

- c. **Downsizing Mains:** When downsizing a main, locate a valve after the reducer on the side with the smaller diameter. However, the designer must evaluate thrust forces and accommodate the forces by placement of a thrust collar (if required) on the larger main.
- d. **Concrete Blocking under Valves:** Provide concrete or solid brick blocking on solid foundation under valves placed on all mains and beneath valves connected to tapping sleeves.

D. Piping Material Applications

- a. **General:** Use pipe, fittings, and methods of joining in accordance with the following:

MATERIAL	WATER MAINS	WATER SERVICES	BACKFLOW PREVENTION BOXES/VAULTS
UNDERGROUND APPLICATIONS			
Ductile Iron	6-inch thru 48-inch	3-inch and larger	3-inch thru 48-inch
PVC C-900, Class 150	6-inch through 12-inch	Not allowed	Not allowed
Type K Soft Copper	Not allowed	1-inch through 2-inch	Not allowed
<i>PE 3408, SDR 9, 160 psi working pressure</i>	<i>Not allowed</i>	<i>1" through 2-inch</i>	<i>Not allowed</i>
PVC ASTM D2241, SDR 21, 200 psi rating	2-inch	Not allowed	Not allowed
Brass Pipe	Not allowed	Short sections of 2-inch	1-inch thru 2-inch
ABOVE GROUND APPLICATIONS			
Ductile Iron	6-inch thru 12-inch	Not allowed	6-inch thru 48-inch
Brass Pipe	Not Allowed	Not Allowed	1-inch thru 2-inch

- b. **Tracer Tapes:** 2-inch wide blue warning tape marked "Caution Water Main Below" shall be installed in the ditch over all PVC water mains.
- c. **Tracer Wire:** 10-gauge bare copper wire shall be installed along the top of all nonmetallic pipe. The wire shall be continuous and uninterrupted. A sufficient excess length of wire shall be left in each valve box to provide at least 2 feet of length above finished grade.

E. **Joint applications**

PIPE	JOINT TYPE	COMMENT
UNDERGROUND APPLICATIONS		
Ductile Iron Pipe	Push On	6-inch thru 48-inch
Ductile Iron Fittings	Mechanical Joint	6-inch thru 48-inch
PVC C900	Push On or Butt Fused	6-inch through 12-inch
Type K Soft Copper water service	Flare type brass fittings	1-inch and 2-inch
PE 3408 water service	<i>Compression w/ solid stainless steel inserts</i>	<i>1" through 2-inch</i>
PVC ASTM D2241	Bell & Spigot w/ gasket	2-inch only
Brass Pipe	NPT threaded	Short sections of 2-inch
Stainless Steel	NPT threaded	Short section of 2-inch
ABOVE GROUND APPLICATIONS		
Ductile Iron	Flange Joint	6-inch thru 48-inch
Brass	NPT threaded	1" thru 2-inch
Stainless Steel	NPT threaded	1" thru 2-inch

- 1) Galvanized pipe and galvanized fittings are not permitted in the City of Jacksonville water system.
 - 2) PVC glued or threaded pipe or fittings are not permitted in the City of Jacksonville water system.
 - 3) Provide transition couplings and special fittings with pressure equal to or exceeding the pressure rating of the pipe or fitting to which they will be either connected or fitted.
 - 4) Do not use flanges, unions, or keyed couplings for new underground piping. With the approval of the City Public Services Director, they may; however, be used in above ground applications such as vaults. 3-part unions may be used for repairs.
- F. **Location:** Water mains shall be located within dedicated street rights-of-way or publicly dedicated easements.
- G. **Fire Hydrants:** Fire hydrants shall not be installed on mains less than 6 inches in diameter.
- 1) **Fire Hydrant Location:** Hydrants shall be located in accordance with Appendix C, *Fire Hydrant Locations and Distribution* of the NC Fire Prevention Code.

- 2) **Pavement Reflector:** A permanent raised bidirectional one color (blue and blue) pavement marker shall be placed at the centerline of the road directly in front of the fire hydrant.
- 3) **Hydrant location requirements for uses other than residential single family:** Hydrant spacing and location shall be reviewed and approved by the City Public Services Director and the Fire Marshall.
- 4) All hydrants are to be located in a street right-of-way or City of Jacksonville public utility easement.
- 5) **Minimum Fire Flow at Hydrants:** The minimum design fire flow for residential subdivisions shall be 1000 gpm with 20-psi residual flow. Each phase shall be required to meet this requirement. For nonresidential subdivisions (commercial, multi-family, etc), the minimum flow shall be no less than 1500 gpm; however, the NC Fire Prevention Code, as updated from time to time, shall be utilized in determining the estimated water needs for fire protection.
- 6) **Maximum Distances from Structures:**
 - i. **Residential:** 500 feet by the pull of the hose method (not as the crow flies) to the building.
 - ii. **Commercial & Multi-family:** See Appendix C of the NC Fire Prevention Code
- 7) **Minimum distances from a structure:** No new hydrant shall be located closer than 40 feet from a structure.
- 8) **Hydrant in relation to street:** See [standard details 514.01](#) and [514.02](#).
- 9) **Services on Fire Hydrant Branches:** Services on fire hydrant branches are not permitted.

H. Pressure:

- 1) **Minimum System Pressure:** Water distribution mains shall be sized to provide a minimum pressure at all points within the distribution system of not less than 20 psi (gauge) during periods of peak demand (fire flow). Systems not designed for fire flows shall have the capacity to maintain a pressure of at least 30 psi (gauge) throughout the system during periods of peak flow.
- 2) **Pressure Zones:** The City of Jacksonville's distribution system consists of two pressure zones, 200 feet and 130 feet. Interconnection of pressure zones must be approved by the City Public Services Director, and shall be separated by a zone separation check valve assembly. Contact the Engineering Department to find out which pressure zone an existing or proposed development is located in.

Connecting varying pressure zones: In the case where high and low pressure systems are to be connected, as directed by the City Public Services Director, a fire hydrant shall be installed on the high-pressure side with a lever and weight check valve positioned with direction of flow from low to high pressure. The check valve shall be installed in an underground vault. In all other applications, where two different pressure zones are connected, a gate valve shall be set. The City Public Services Director may require a sign to be erected at or near the valve denoting the valve as a "Pressure Zone Division Valve."

3) **Limits of service based on pressure:**

200-foot Pressure Zone: The City of Jacksonville will not serve elevations above 160 feet, based on United States Geological Survey (USGS) maps, in the 200-foot pressure zone. Elevations below 27 feet (USGS) may require a pressure-reducing valve on private service lines.

130-foot Pressure Zone: The City of Jacksonville will not serve elevations above 90 feet (USGS) in the 130-foot pressure zone.

- 4) **Pressure Reducing Valves:** When the maximum static pressure in a new system exceeds 80 psi, businesses and/or residences shall be equipped with a pressure-reducing valve. The valve shall be located on private service lines. The NC State Plumbing Code covers the installation of pressure reducing valves. The pressure reducing valves are neither owned by nor maintained by the City of Jacksonville.
- I. **Bury:** Water mains shall be designed with a minimum bury of 36 inches cover and a maximum of 72 inches of cover, as measured from the top of crown to the finished grade, unless approved otherwise by the Public Services Director. Under conditions which otherwise prevent 36 inch bury, such as at crossings above shallow buried structures or rock, the pipe shall be Ductile Iron and the minimum cover shall be 24 inches, as approved by the Public Services Director. Lines which have no more than 18 inches of cover at ditch or culvert crossings shall be Ductile Iron and encased in concrete for a length of 5 feet on each side the ditch or culvert or utilize a higher pressure class pipe. Such encasements or increase in pressure class shall require approval of the Public Services Director.
- J. **Horizontal and Vertical Blocking:** Concrete thrust blocking, tie rods, restrained joint pipe, and/or other means of restraint shall be provided at all changes in pipe direction. Concrete thrust blocking is not recommended where the blocking may bear on other utilities or where the area behind the block may be excavated in the future.
- K. **Dead end lines:** Blowoff assemblies shall be installed at the end of all water mains and as required for flushing, as directed by the Public Services Director. Temporary blowoff assemblies shall be installed on lines that may be extended. Permanent blowoff assemblies shall be installed on lines that will not be extended. The following blowoff sizes shall apply for the applicable main size:

Main Line Size	Blowoff Size Required	Blowoff Valve Size	Standard Detail Reference
Permanent Blowoff Assemblies			
6, and 8-inch mains	2-inch	2-inch	514.05
12-inch mains	4-inch	4-inch	514.06
16-inch mains and larger	6-inch	6-inch	514.06
Temporary Blowoff Assemblies			
6-inch thru 24-inch	2-inch	Valve to match main size ^a	514.05

^aA temporary blowoff shall have a full 18-foot joint of pipe between the valve and the standpipe.

The maximum length of a permanent dead end 6 and 8-inch main shall be 700 feet and 1200 feet; respectively, unless approved by the City Public Services Director. A fire hydrant is required at the dead end.

- L. **Sag Vertical- Sag Blowoffs:** When directed by the City Public Services Director, provide a sag blow-off when lines have severe sag where sediment can accumulate and retard flow in water line (such as when running beneath large streams, ditches or culverts).
- M. **Crest Vertical – Air Release Valves:** Where water mains are subject to air entrapment, provide an air release valve constructed in accordance with [standard detail 513.05](#), as applicable, located at the highest elevation on the main. Where the main undulates along its length and several crests are encountered, a separate air release manhole will be required at each crest. The City Public Services Director, before placement, shall approve the final actual location of all air release manholes. Typically, when the relative elevation difference in a water main (from the main's sag elevation to the crest elevation) is greater than 25 feet, an air release valve will be needed.

A 1-inch air release valve shall be used on water mains from 2-inches to 12-inches in diameter. A 2-inch air release valve shall be used on water mains 16 inches and larger in diameter. Refer to air release valve manufacturer's recommendations for air release sizing and quantity.

The valve shall be used to bleed air from the line as it is filled with water for testing.

Manhole Size Determination:

- a. The minimum diameter of manholes shall be 5 feet.
 - b. Manholes with 16-inch diameter or larger pipe shall be a minimum of 6 feet in diameter.
- N. **Vertical upward thrust:** Vertical upward thrust at fittings or vertically deflected joints shall be resisted with thrust collars of adequate size and weight, pilings, or other acceptable methods approved by the City. See [standard details 512.03 and 512.04](#).

O. Relation of Water Mains to Sewers:

See specification [Section 02510 – Water Distribution](#), Part 1 - General, paragraph [1.9 Project Conditions](#) for separation requirements between water mains and sewer mains/structures and between water mains and other utilities/structures.

P. Stream crossing:

Where possible, all stream crossings shall be made below water level. Stream crossings shall be made as close to a 90-degree angle as possible. All stream crossings shall be made with ductile iron pipe. A valve shall be placed on each side of the crossing and restrained; in the event the line is lost, by anchor blocks.

Below streambed crossing: Unless otherwise permitted by the City Public Services Director, streambed crossings shall be made using DIP with no less than 3 feet of cover. If less than 3 feet of cover is necessary, the pipe shall be encased in concrete. With concrete encasement, the minimum bury (to top of pipe) shall be no less than 18 inches.

Above stream crossing: Water mains crossing streams above normal water level shall be placed above the 25-year storm elevation when practical and otherwise meet DWQ requirements for stream crossings. Stream crossings above water level shall be constructed with piers or other suitable methods approved by the City Public Services Director.

Hanger Support from Bridges: In the design of the aerial system, provide both details and calculations showing the hanger type, hanger capacity, hanger-to-bridge attachment type (mechanical or chemical), and capacity with a minimum safety factor of 3. Assume the pipe is full. Provide lateral bracing of hanger to a girder or to bottom of bridge deck. Two pipe hangers per pipe joint shall be required. Provide plans showing the plan view and elevation of the water line crossing.

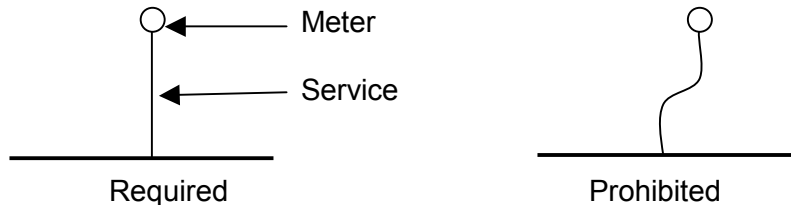
Thermal Protection, allowance for main expansion: Where aerial crossings are approved by the City, install expansion devices as necessary to allow for expansion and contraction movement in pipe, such as on aerial bridge or creek crossings. Expansion joints are typically to be provided where the line transitions from aerial to underground. Provide calculations showing expected differential movement. To prevent freezing, provide either pipe insulation jackets that totally cover the pipe (so that the pipe and insulation is placed inside the hanger assembly) or an insulation system that covers both the pipe and hanger assembly.

Q. **Taps:** taps shall be made in accordance with the following table:

Service Size	Type Tap Allowed	Standard Detail Reference	Comments
1-inch	Wide or Double Strap Bronze saddle or direct tap	513.03 & 515.01	None
1 1/2 & 2-inch	Wide or Double strap bronze saddle	515.02	None
3-inch	Not allowed	-	3-inch water meters shall be served by a 4-inch tap with 4-inch service lines.
4-inch thru 12-inch	Tapping sleeve & valve	513.02	None

R. **Water Services**

General: A water service shall be provided for each lot. The meter box shall be located **1 foot** from the back of the curb, within the public right of way (see [standard detail 515.01](#)). Services shall be placed perpendicular to the main and shall not meander or snake in such a manner as to offset the meter from its main connection point (see schematic below). The meter box shall be set flush with the finished grade and shall not be installed in a ditch slope. In situations where the meter box is located outside of the public right-of-way, a water easement shall be provided to the City.



For multi-family housing, individual water meters are required unless a variance is requested of, and approved by, the City Council and master metered.

Meter Location – double frontage lots: If a lot fronts on two or more streets, the meter shall be located within 5' of the sewer service.

S. **Combination Vaults:** Vaults shall be designed and constructed to provide minimum clearances between the pipe, fittings or vault walls per the dimensions prescribed in the applicable vault detail(s). See [standard details 515.04, 519.01 & 519.02](#). See the applicable detail for the particular type application proposed.

T. **Multiple Feeds**

Water systems with multiple feeds require the installation of double check valve assemblies on the downstream side of each meter, unless the use of the facility

requires a RPZ in accordance with the City of Jacksonville's *Water System Cross-Connection Control Ordinance*, Article VI of the City Code, latest revision.

U. Cross-connection prevention

Approved backflow prevention assemblies shall be installed on the service line to all facilities. All backflow units shall be installed in enclosures and located at the right-of-way line for fire lines and private distributions systems. They should be directly behind the meter for domestic service lines. See **standard details 519.01 & 519.02**, as applicable. See also the City of Jacksonville's *Water System Cross-Connection Control Ordinance*, Article VI of the City Code, latest revision for hazard classification and type backflow device requirements.

V. Testing:

General: The City of Jacksonville will provide water for testing purposes on water mains. Refer to technical specification [section 02510 – Water Distribution](#), paragraph [3.4 – Testing and Disinfection](#) for required testing requirements and methods. Testing of completed water mains shall include the following:

- 1) Hydrostatic Testing
- 2) Chlorination and Bacteriological Test; HPC Test

1.3 GRAVITY COLLECTION SYSTEM DESIGN STANDARDS

The purpose of this module is to establish standard design procedures and criteria for sewer system design on systems owned and maintained by the City of Jacksonville.

1.3.1 GENERAL

- A. **General:** Gravity Collection systems shall generally meet the minimum requirements of the State of North Carolina Department of Environment and Natural Resources, NCAC Title 15A 02H .0200 *Waste Not Discharged to Surface Waters*, latest revision.

1.3.2 DEFINITIONS

- A. **Definitions:** For the purposes of this specification, the following definitions refer to sanitary sewer collection systems that come under the authority of the City of Jacksonville as specified within this section and other sections of this manual.

- 1) **Main or Trunk Sanitary Sewer:** Exterior gravity sanitary sewer systems receiving flow from one or more lateral or mains.
- 2) **Sewer Service:** Exterior domestic sewer piping serving a private residence, business, commercial facility or

industrial user.

- 3) **Interceptor:** Sewer that receives flow from a number of gravity mains or trunk sewers, usually placed along a stream or river.

B. The following are industry abbreviation for various pipe materials:

- 1) **DIP:** Ductile Iron Pipe
- 2) **HDPE:** High Density Polyethylene Pipe
- 3) **PVC:** Polyvinyl Chloride Plastic
- 4) **RCP:** Reinforced Concrete Pipe

1.3.3 COLLECTION SYSTEM DESIGN

- A. **Minimum Size/Sizing:** No public gravity sewer conveying wastewater shall be less than 8 inches in diameter. No private gravity sewer conveying wastewater shall be less than 4 inches in diameter.
- B. **Developments:** Wastewater flows for developments with localized sewers shall be determined in accordance with NCAC Title 15A 02H .0219 *Minimum Design Requirements*.
- C. **Main Depths:** The depth of sewer mains shall be great enough to serve adjoining property, allowing for sufficient grade on service lines. Main depth shall also take into consideration potential conflicts with parallel pipe systems (such as water mains and storm drainage lines), providing room for the service laterals to pass either over or below lines.
- D. **Extensions to Adjacent Property:** Where tributary flow is expected from an upstream natural drainage basin, designers shall provide easements for future extensions of sewer mains to the farthest property line of the tract.
- E. **Acceptable Pipe Material**
 - 1) Refer to **Part 2 - PRODUCTS** of section 02530 – *Sanitary Sewer* for detailed specifications for pipe and fittings listed below. Use pipe, fittings, and joining methods according to the application indicated.

Allowable Materials for Gravity Sewer Pipe up to 18 inches in diameter	
Services Gravity Mains	Sch 40 PVC, Class 350 DIP, Class 350 DIP, C900 PVC Class 150, DR18, SDR 35 PVC, PVC Truss Pipe (8" and 10" ONLY)

Allowable Materials for Gravity Sewer Pipe 21 to 48 inches in diameter	
Gravity Mains	Class 350 DIP, Class III or IV RCP lined

Allowable Materials for Force Mains		
DIP	Class 350	
PVC	4-inch and larger	^a C900 PVC, Class 150, DR18 w/ Ductile Iron Fittings
HDPE	4-inch through 12-inch	^a AWWA C901 or AWWA C906 with Hydrostatic Design Basis (HDB) of 1250 psi (PE2406) or 1600 psi (PE3408)

^aC900 PVC & HDPE may be used with prior approval only.

- 2) PVC sewer force mains are permitted under paved surfaces on a case by case basis as determined by the Public Services Director.
 - 3) A-2000 PVC, ABS Truss, and VCP gravity pipe are not permitted.
- F. **Location:** All sewer mains shall be installed within the street right-of-way or within a dedicated City of Jacksonville sewer or utility easement. When located in street right-of-way, the sewer main shall be in the center of the pavement or right-of-way, as much as practical.
- 1) Plan Requirements:
 - a. Manhole number and station.
 - b. Manhole top and invert elevations
 - c. Benchmark reference (elevations must be tied to mean sea level reference datum).
- G. **Bury:** A minimum of 36 inches of cover shall be provided for all sewers. The City Public Services Director must approve all installations of sewer lines with less than 36 inches of cover.
- H. **Slope:**
- 1) **General:** All sewers shall be designed and constructed to give mean self-cleansing velocities of not less than 2.0 feet per second, based on Manning’s formula using an “n” value of 0.013 – this includes evaluating sewers flowing partly full. The following are the minimum slopes that shall be provided; however, slopes greater than these are recommended.

Minimum Slope	
Sewer Size (inches)	Minimum Slope (%)
8	0.40
10	0.28
12	0.22
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08

- a. **Uniform slope between manholes:** Sewers shall be designed with uniform slope between manholes.

Grade variation from required minimum slope: The line is to be inspected for conformance with line and grade shown on the plans. The City of Jacksonville shall be provided with record drawing measurements (including actual distance between manholes and the as-built invert in and invert out elevations) on the As-Built Drawings. The maximum allowable drift between structures from the proposed alignment is:

Horizontal alignment: 0.50 foot (applies to manholes)

Vertical alignment:

Maximum Slope: The maximum grade shall not exceed 10%.

Minimum Slope: No tolerance below the NCDENR minimum slopes will be allowed. If the slope in the pipe is found to be less than acceptable the Contractor shall relay the pipe.

- b. **Slope Increase:**
- i. On upper reaches of small services and mains, due to water saving fixtures now employed, the designer should consider increasing the slope of gravity services above the minimum allowed in order to flush solids.
 - ii. Special attention must be given to the early years that the new public system is used, as initial flows may be substantially lower than design flows and the velocities well below the minimum. The designer or the City Public Services Director may direct usage of greater slope.
- c. **Pipe size increase:** Sewers may not be upsized more than 1 OD pipe size to gain flatter slopes. If the minimum scouring velocity cannot be maintained during initial operation prior to the design flow capacities being reached, the developer may be required to periodically flush the system until volume has increased to affect a self-cleansing velocity.
- d. **Maximum Slope:** Maximum grade for sanitary sewers is 10%. Grades greater than 10% should be avoided if possible.
- e. **Steep Slope Protection:** Any time the grade is 10% or more, concrete collars shall be provided to prevent creep and/or to prevent water from flowing along the pipe and causing trench scour. Manholes shall be protected from corrosion generated by release of hydrogen sulfide gas from high turbulence associated with line velocity.
- f. **High Velocity Protection:** Where design velocities are projected to be greater than 10 fps, the sewers and manholes shall be protected against

internal erosion and impact by high velocity. Pipe shall conform to ASTM, AWWA, ANSI, etc., which provide protection against erosion. For velocities greater than 20 fps, erosion control measures shall be documented on the “Record Drawings” and the Engineer’s Certification.

- g. **Sewers placed in predominantly silty fine-grained soils:** The designer should consider placing either clay or concrete collars (dams) periodically along sewers constructed in and backfilled predominantly with silty soils – regardless of slope. Migration of fines from adjacent soil and loss of pipe support is possible. Either provide suitable bedding with Class II or place a non-woven separation geotextile fabric between the stone and the earthen backfill. See [standard detail 511.01, sheet 2](#) for a description of the material classifications and for recommendations for installation and use of soils and aggregates for foundation, embedment and backfill.
- I. **Alignment:** All sewers shall have a straight alignment between manholes.
- J. **Changes in Pipe Size or Material:**
 - 1) **Pipe Size Changes:** Gravity sewer sizes shall normally remain constant between manholes. Pipe size changes shall occur only at manholes. When a smaller sewer joins a large one, the inverts of the sewers shall be arranged to maintain approximately the same energy gradient whenever possible. 0.8 times the pipe diameter of the two lines shall match.
 - 2) **Undersized or substandard downstream sewers:** Sewer extensions shall be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole, with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. Justification shall be provided at the end of the project with the as-built drawings indicating that the capacity of the downstream sewer will not be overloaded by the proposed upstream installation. The City of Jacksonville reserves the right to prohibit additional flow into an undersized sewer for new growth.
 - 3) **Pipe Material Changes:** To avoid couplings of dissimilar material, pipe material must remain consistent between manholes and may not be changed. The manhole drop material should conform to [standard detail 532.06](#).
- K. **Uneven inverts of parallel pipelines in same trench:** Where more than one pipeline is laid in the same trench and the invert elevations are not identical, and where no concrete cradle or encasement is provided for the support of the high pipeline, its foundation shall be considered to be yielding. When bridging is required to support a portion of the pipeline over such yielding trench bottom, it shall not be considered to provide bridging strength. #57 stone shall be provided and used for this purpose.
- L. **Buoyancy:** Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where shallow cover and high

groundwater or flooding conditions are anticipated. For design purposes, assume water to top of pipe and pipe is empty.

M. Connections to Existing Mains: Connection to existing sewer mains shall be made at manholes.

N. Service Connections:

- 1) Services connected to gravity sewers shall be connected using in line wyes (**standard detail 533.03**) or saddles. In-line wyes shall be used for all service connections to new lines. Service saddles may be used on existing mains (see **standard details 533.01 and 533.02**).
- 2) A cleanout will be installed on each house service. Unless topography permits otherwise, services are to be placed either in the middle of the lot or 3' from the property line. The cleanout shall be located within the right of way or easement. If the cleanout falls within concrete or asphalt, a cast iron valve box shall be installed over the cleanout (See **standard detail 533.03**, sheet 1).
- 3) Minimum grade for 4-inch and 6-inch services shall be in accordance with the North Carolina State Plumbing Code, latest revision.
- 4) **Service connections to manholes:** Unless approved otherwise by the City Public Services Director services connections to manholes shall be made at dead end lines only. Service connections must enter the bottom of the manhole when ever possible. If not practical, services may be located above the bottom but may not enter the cone or it's joint. Service connections in manholes shall also be core bored and booted and shall be separated by a minimum of 2 times the pipe OD (either vertically or horizontally) from other services or mains.
- 5) Vertical stacks or standpipe services are not allowed except as shown on **standard detail 533.03**.
- 6) **Services on Utility Easements:** All services going into a sewer/utility easement should be connected to the sewerline where practical. Cleanouts, typically located at the easement line, must be at ground level.

O. Public Easements: Easements across lots, or centered on rear or side lot lines, shall be provided for utilities where necessary, and shall be at least 20 feet wide, which said easement may be a part of the vehicular access easements. The width of easements (except when adjacent and parallel to right-of-way) shall be based on the following:

Sewer Lines	Min. Easement Width (feet)
Sewer Easements	20-30*
Combinations Easements (Sewer with either Water or Storm Drainage)	25-30*

*Depending on the depth of the sewer main

Consideration shall be given for deeper cuts (generally greater than 12') by including an additional temporary construction easement (usually 10' - 20'). The City may require that the width of the permanent easement increase with a depth of sewer as determined by the City Public Services Director for maintenance purposes.

Easements shall be fully accessible by rubber-tired vehicles in their entirety. The City of Jacksonville may require stream fords for larger streams provided crossings are consistent with NCDENR Division of Water Quality and USCOE requirements.

All off-site easements shall be acquired by the developer and dedicated to the City of Jacksonville by recorded map and by deed of easement prior to approval of the project for construction. Easements for vehicular access shall be provided with a maximum 4:1 grade.

No building or other obstruction shall be erected and no trees or shrubbery shall be planted on any easement.

- P. **Testing:** See specification section 02530 *Sanitary Sewer*, paragraph 3.9 *Testing* for testing requirements.
- Q. **Allowable Leakage:** No leakage is allowed for PVC or DIP sewer. Allowable leakage for RCP sewer (greater than 21 inches) shall be **100 gallons** per inch nominal diameter per mile of pipe per 24 hours.

1.3.4 DESIGN – MANHOLES

A. Location

- 1) **General:** Manholes shall be installed on all mains 8 inches and larger. Manholes shall be installed at the end of each line, at all changes in grade, at changes in main size or alignment, at all intersections.
- 2) **Spacing:** Manholes shall be placed at distances no greater than 400 feet.
- 3) **Cleanouts:** Cleanouts may be used in lieu of manholes on 4 and 6-inch private lines with distances between cleanouts in accordance with the NC Plumbing Code, latest revision.

B. Diameter

- 1) **Minimum Diameter:** The minimum diameter of standard manholes shall be 4 feet. The minimum diameter of drop manholes shall be 5 feet.
- 2) **Standard Manhole Diameter Based on Pipe Size:**

Line Size	Minimum Diameter
8 through 12 inches	4-foot in diameter*
15 through 24 inches	5 feet in diameter

***the number of connections or angle of connections may require a larger diameter manhole.**

3) **Standard Manhole Diameter Based on Depth:**

Depth	Minimum Diameter
Manholes 0 to 15'-0"	4-foot in diameter*
Manholes greater than 15'-0" deep	5 feet in diameter

***the number of connections or angle of connections may require a larger diameter manhole.**

- 4) **Extended Bases:** All manholes shall have extended bases with appropriate reinforcing.
- 5) **Moorbases:** Moorbases are not permitted.
- 6) **Cones:** Eccentric cones are required to be used on all mains.
- 7) **Minimum drop across invert:** The minimum drop between manhole invert in and invert out is 0.04 feet on straight junctions. Other drops (H), where there is no change in pipe size, can be computed by applying the following headloss (K) coefficients to the velocity head:

$$H = K \left(\frac{V^2}{2g} \right), \text{ where}$$

H = Vertical drop across invert of manhole (ft)
 K = Headloss coefficient (from table below)
 V = Average velocity in influent pipe (ft/sec)
 g = Acceleration of gravity (32 ft/sec²)

Condition	K
For bends at junctions of 25 degrees	0.30
For bends at junctions of 45 degrees	0.40
For bends at junctions of 90 degrees	0.60
For junctions of 3 pipes	0.80
For junction of 4 or more pipes	1.00

(Reference: King's handbook of Hydraulics)

Drops through manholes shall be indicated on the drawings by invert in and invert out elevations.

C. **Drop Type**

- 1) **Inside Drops:** An inside drop shall be provided for a sewer entering a manhole at an elevation greater than 24 inches or more above the invert of the manhole unless sewer pipe crown elevations match. The minimum diameter of inside drop manholes shall be 5 feet. See [standard detail 532.06](#).

- 2) **Outside Drops:** Not permitted.
- 3) **Service taps in manholes:** If a service is proposed in the manhole, no drops will be allowed for services except due to depth of main or otherwise approved by the City Public Services Director. See paragraph 1.3.3, O, 4), [Service Connections to Manholes](#) above for other requirements relating to taps into manholes.

D. Water-tightness

- 1) Manholes shall be pre-cast concrete.
- 2) **Pipe connections to Manholes:** Inlet and outlet pipes shall be joined to the manhole with gasketed flexible watertight connections (rubber boots). See [standard details 532.01, 532.02, 532.03 & 532.06](#).
- 3) **Manholes in streets or adjacent to streets:** Manholes subject to flooding by street water or located in flood prone areas shall have watertight covers.
- 4) **All sanitary sewers in utility easements** (other than those running parallel to creeks and/or located in a flood plain): Unless otherwise approved by the City Public Services Director, manholes shall be flattop with cast-in-place bolt-down watertight frames and covers. All manholes rims must be a minimum of 12 inches above grade.
- 5) **Sanitary Sewer Easements running parallel to creeks and/or located in flood plains:**
 - a. Manholes shall be designed for protection from the 100-year flood by one of the two methods (see [standard detail 532.02](#)):
 - i. Manholes shall be flattop with cast-in-place bolt-down watertight frames and covers.
 - ii. Manholes shall be vented 12 inches above the 100-year base flood elevation. Manholes shall be vented every 1000 feet or every third manhole, whichever is lesser. Maximum vent spacing shall not exceed 1000 feet on watertight sections of main, or
 - iii. Manholes rims shall be 12 inches above the 100-year base flood elevation.

E. Buoyancy: Buoyancy shall be considered and flotation of the manholes shall be prevented with appropriate construction where high groundwater or flooded conditions are anticipated. For design purposes, assume water to top of manhole and that the manhole is empty.

F. Corrosion Protection for Manholes:

- 1) Where corrosive conditions due to septicity or other causes are anticipated, consideration shall be given to providing corrosion protection on the interior of

the manholes. Consequently, drops in interceptor lines or drops into interceptor lines shall be avoided. Drop manholes, if required, shall be provided upstream of interceptor line connection.

- 2) Where high flow velocities are anticipated, the manholes shall be protected against internal corrosive erosion and displacement from impact.

G. **Inspection and Testing:** See technical specification 02530 - *Sanitary Sewer* for manhole testing requirements.

1.3.5 SEWERS IN RELATION TO STREAMS AND OTHER BODIES

All creek crossings, unless otherwise approved by the City Public Services Director, shall be made with ductile iron pipe.

A. **Materials:** Sewers entering or crossing streams shall be constructed of ferrous material pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment of grade and tested to 150 psi. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials, which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

- 1) **Sewers Paralleling Creeks:** Sewers paralleling creeks shall be below the stream elevation, such that lateral connections will be below streambed. In certain circumstances where rock is present, sections of the main may be raised to allow lateral connections above the streambed provided the ability to serve the upstream property is not compromised and the pipe crossing is designed sufficiently restrained to prevent line breakage by the dynamic affects of the stream flow. Sewers shall be placed outside of applicable Watershed and stream/river Buffers.

- 2) **Perpendicular Crossings:** Creek crossings shall be as near to perpendicular to the stream as possible. Sewers crossing creeks shall be placed below the streambed such that there is a minimum of 3 feet bury below the streambed. If the minimum 3-foot bury cannot be attained, either encase the sewer in concrete or design the sewer as an aerial crossing in accordance. Aerial crossings require prior approval of the City Public Services Director. All crossings shall be subject to US COE and NCDENR Division of Water Quality approval and conditions.

B. **Buried Pipe Cover Depth:** The top of all sewers entering or crossing streams shall be at a sufficient depth below natural bottom of the streambed to protect the sewer line. The following cover requirements shall be met:

- 1) 1 foot of cover where the sewer is located in rock:
- 2) 3 feet of cover in other material unless ferrous pipe is specified. In major streams or rivers, more than 3 feet may be required; and

- 3) With approval of the City Public Services Director, in paved stream channels, the crown of the sewer line may be placed below the bottom of the channel pavement.
- 4) With approval of City Public Services Director, less covering will be considered if the proposed sewer crossing is encased in concrete provided the encasement will not interfere with future improvements to the stream channel.

C. Aerial Crossings:

- 1) Creek crossings above water level shall be constructed with piers or other approved support/carriage and shall be approved by the City Public Services Director. The bottom of the pipe should be placed no lower than the elevation of the 25-year flood. Ductile iron pipe with mechanical joints shall be required. In the event the 25-year flood elevation can not be determined or the proposed gravity sewer must be placed below the 25-year elevation, the applicant (for both private and public sewers) will have to issue a certification stating: *“Regular and proper inspection and maintenance of the aerial crossing shall be provided to insure that the creek/stream flow is not impeded and that no damage will be caused to upstream or adjacent properties.”*
- 2) Proper joint technology, such as flanged or restrained, adequate supports to prevent excessive deflection and flexion or a combination of both shall be provided for all aerial pipe crossings. Supports shall be designed to prevent heave, overturning, uplift, and settlement. Supports shall be designed to withstand the hydrodynamic effects of the stream flow pressure using the following formula:

$$P = 1.5KV^2$$

Where,

1.5 = safety factor against overturning (2.5 is recommended),

P = pressure, psf

V = velocity of water, fps

K = 4/3 for square ends, 1/2 for angle ends when angle is < 30° or less and 2/3 for circular piers.

If it is probable that the aerial pipe could be submerged by the stream flow, the effects of the flow pressure on the pipe shall also be taken into account when computing pier-overturning moments. For aerial stream crossings, the impact of floodwaters and debris shall be considered. In streams subject to flooding velocities greater than 5 fps, pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking of appropriate size in the bank. Provide applicable blocking computations and details.

- 3) Precautions against freezing, such as insulation and increased slope, shall be provided.

- 4) Expansion jointing shall be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize heaving. Similarly, special details may be required between above ground and below ground sewer transition to account for seismic forces.
 - 5) Computations:
 - a. Provide structural calculations for any elevated main and pier system where span of the main exceeds the joint length. Provide calculations for all aerial mains, and their supporting structures that are subject to hydrodynamic forces. Calculations are to provide for a minimum safety factor of 2.5 against overturning and 1.5 for uplift. Calculations shall also address applicable seismic loads. Where stream is subject to floating debris such that the pipe system could be broken or separated by the impact forces, pipe joints shall be flexible restrained joints. Pipe crossing shall be anchored in bank in such a way that if all supports are lost, the pipe system will not separate and will be restrained by anchor blocking in the bank. Provide applicable blocking computations and details for review.
 - 6) When steel pipe is used for aerial pipe crossings, the pipe is to be coated inside and outside.
- D. **Structures:** The sewer interceptors, manholes, or other structures shall be located so they do not interfere with free discharge of flood flows of the stream. Portions of manholes above grade subject to hydrodynamic forces of flooding shall be designed to resist the flood forces with a safety factor of 2.5 considerations shall be given for impact from debris. See [paragraph C](#) above.
- E. **Anti-Seepage Collars – wetland areas:** In areas where the sewer trench has the potential to drain wetlands, anti-seepage collars shall be installed. In these areas, a US Army Corps of Engineers 404 Wetland Permit and/or a NCDENR 401 Water Quality Permit may be required.
- F. **Environmental - Buffer Requirements:** A minimum buffer separation of 50 feet shall be maintained between sewers and streams/waters classified as nutrient sensitive streams or watershed buffers (from normal high water). See also NCDENR NCAC Title 15A 02H .0200 for other requirements regarding minimum separation with streams, lakes and impoundments. Before crossing streams or ditches, working within 100 feet of private or public water supply sources or 50 feet of non-water supply ponds, lakes, or rivers, the Designer shall verify whether either the line is exempt or obtain a permit to encroach into a watershed or nutrient sensitive river basin buffer. Unless otherwise permitted, water or sewer mains crossing a stream, river, pond, or lake buffers are to be as near perpendicular as possible (the crossing is considered perpendicular if it intersects the stream or surface water between an angle of 75 and 105 degrees). Do not disturb more than 40 linear feet (longitudinal) of a riparian buffer. Adhere to all of the following Best Management Practices in Zone 1 (the lower 30 feet beside the stream or water) during design/construction.

- 1) Woody vegetation is to be cleared by hand. No grading allowed.
- 2) Stumps to remain except in trench where trees are cut. Minimize disturbance to roots in buffer zone.
- 3) Backfill trench with the excavated soil immediately following installation.
- 4) Do not use fertilizer except for the one-time application to reestablish vegetation.
- 5) Minimize removal of woody vegetation, the amount of disturbed area, and the time the disturbed area remains disturbed.
- 6) Take measures to ensure diffuse flow of water through the buffer after construction.
- 7) In wetland areas, use mats to minimize soil disturbance.
- 8) Separate topsoil from the excavated material so that the original top soil is replaced over the excavated area.

1.3.6 PROTECTION OF POTABLE WATER SUPPLIES AND STORM SEWERS

- A. **General:** See specification [section 02530 – Sanitary Sewer, Part 1- General, paragraph 1.10 Project Conditions](#) for separation requirements between water mains and sewer mains/manholes and water mains and drainage structures/streams.
- B. **Sewer/Well Conflict:** If a sewer main must be placed closer than 100 feet of the well, ferrous sewer pipe with joints equivalent to NCDENR water main standards shall be used; however, no ferrous pipe gravity sewer, ferrous pipe force main, or manhole structure shall pass or be placed within 25 ft of a private well or 50 feet of a public water supply well, source or structure. If the sewer line must be installed within 25 feet of a well, the well shall be capped and the property shall be required either to connect to the City of Jacksonville's water system, if available, or the existing well must be abandoned according to NCAC Title 15A 2C .0100 *Well Construction Standards*, latest revision, regarding guidelines for well abandonment and construction of a new well drilled meeting the setback requirements.

1.3.7 PUMP STATIONS

A. **General:**

Pump stations and force mains will be allowed only with the permission of the City Public Services Director.

Pump stations shall be City of Jacksonville standard. Pumps may be either self-priming or submersible grinder pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater.

Self-priming pumps: Self-priming pumps shall have alternating (transducer or float) system switches. Pumps and related controls shall be enclosed in a building. Though not preferred, with the City Public Services Directors prior approval, a rollback "Quonset" style fiberglass enclosure may be permitted. Pumps shall be capable of handling a 3-inch solid and any trash or stringy

material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by passing solids, trash, and stringy material through a non-clog impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material.

Submersible Pumps: Submersible pumps shall have transducer or mercury float control switches with electro-mechanical controls. See [standard detail 534.02](#) for typical pump station site layout. Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by either passing solids, trash, and stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material.

Lift stations shall include the following as a minimum:

- 1) Inspection and Testing: See technical specification 02800 Sanitary Sewer for manhole testing requirements.
- 2) Service head, meter base, service connection, disconnect, and area light with switch.
- 3) Audible and visual high water alarm and alarm silence.
- 4) SCADA System shall be required and reviewed on a case-by-case basis by the Public Services Director for compatibility with the City of Jacksonville system.
- 5) Automatic air release valves, as applicable.
- 6) For self-priming pumps, provide floats or transducer type control system with hand-off-automatic (H-O-A) switches and an automatic alternator. For submersible pumps, provide mercury float switches for level control.
- 7) High water alarm circuitry.
- 8) 3-phase voltage monitor, if applicable. Indication of 3-phase power fail.
- 9) Suction and/or discharge gauges, as applicable.
- 10) Elapsed time indicators.
- 11) High pump temperature protection.
- 12) Pump run lights.
- 13) Motor overload resetter
- 14) Surge suppressor.
- 15) Duplex service receptacles on GFCI.
- 16) Surge relief valve and return piping to wetwell.
- 17) Start-up assistance and certification, including operational/witness/drawdown test. Certified pump curves shall be provided as part of the project closeout documents.
- 18) Dual power supply auto switchover, etc.
- 19) For self-priming pump stations, provide heaters and fluorescent lighting.
- 20) The lift station is to include back-up alarm system that operates off a 12-volt battery connection in the event of power failure. The battery system is to include a trickle charger to ensure battery integrity.
- 21) Provide auxiliary natural gas or diesel fired automatically activated stand-by power generator source with automatic reset, placed on site. Pump

manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. Generator shall have the capacity sufficient to sequentially start and run all pumps in the pump station. The Contractor shall provide a complete engine driven generator set. The generator set shall consist of four-cycle, radiator-cooled, engine direct connected to an alternating current generator, a unit-mounted control panel, all mounted on a common sub-base. The control panel shall be complete with engine controls and instruments, safety controls and panel lights including the following:

- a. The generation unit shall be capable of powering the pump motors starting current, electrical systems, instrumentation /controls and alarm systems, and other auxiliary equipment as may be necessary to provide for the safe and effective operation of the pump station. The generation unit shall have the appropriate power rating to start and continuously operate under all connected loads.
- b. The generation unit shall be provided with special sequencing controls to delay lead and lag pump starts unless the generating unit has the capacity to start all pumps simultaneously while the auxiliary equipment is operating.
- c. The generation unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
- d. The generation unit shall be protected from damage when restoration of power supply occurs.
- e. The generator shall be equipped with an automatic transfer switch to start generator and transfer load to emergency in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss.
- f. The control panel shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; AC voltmeter; voltage adjustment; frequency meter; and running time meter.
- g. Circuit breakers shall be provided with a built in control panel.
- h. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
- i. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
- j. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes.
- k. The automatic transfer switches must have a disconnect on the utility service main side.
- l. The generator shall comply with the following minimum requirements:
 - i. Engine: Four-cycle, 4 cylinder, radiator cooled, at 1800 RPM. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature.
 - ii. Generator: Rating shall be continuous standby service at 0.8 power factor, at 1800 RPM.
 - iii. Voltage: Three-phase, 208. KW rating to match facility needs.

- iv. Engine shall be equipped with an isochronous governor as manufactured by Woodall.
- v. Frequency regulation shall be less than 3-cycles from no-load to full load.
- m. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
- n. The generator set shall be enclosed with a factory-installed weather-protective housing (sound abating enclosure to 68db @ 23 ft.) Housing shall provide easy access to the engine-generator and instrument panel. Muffler to be designed so exhaust is not blown or sucked across the set by cooling air.
- o. Included with the generator shall be a complete fuel system consisting of a fuel tank, fuel gauge, fuel lines, fuel pumps, valves and any and all other items incidental to a first-quality installation.
- p. Provide integral sub-base double-walled diesel tank. The tank is to be UL approved closed-top dike type. The tank shall also be fitted with a leak sensor device. The tank must have a capacity to run the generator for a minimum of 48 hours at 100% load.
- q. Provide a drain plug at one end of the rupture basin. Provide vibration isolators between generator set and tank assembly. Provide fuel low-level alarm remote mounted.
- r. Provide manufacturer's recommended anti-freeze and engine block heater, per manufacturer's recommendations, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements, adjustable if possible. Provide suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
- s. Provide annunciator panels with visual and audible alarms to monitor and warn of emergency operation conditions affecting line and generator power sources.
- t. Provide stainless steel super critical grade type exhaust silencer mounted inside of the generator enclosure for corrosion protection.
- u. Provide amp meter, voltmeter, and frequency meters with phase switches.
- v. Provide fuses or circuit breakers for battery charger and engine.
- w. Provide an automatic battery charger, static type, magnetic amplifier control with DC voltmeter, DC ammeter and potentiometer for voltage adjustment. The charger is to be completely automatic and rated for the type of battery use. The charging rate is to be determined by the state of the battery and reducing to milliamp current on fully charged battery. The charger shall be 120 V., single-phase, 60 cycle, AC input with 6-amp maximum output.
- x. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
- y. The City must be furnished with one complete set of air, oil and fuel filters.

B. Station Design:

- 1) Design of station shall be according to the provisions of NCDENR, Division of Environmental Management NCAC Section 15A 2H 0.200 – *Waste Not Discharged to Surface Waters*.
- 2) The pump station shall have a 100% reserve peak pumping capacity (dual pumps) and be capable of pumping at a rate of 2.5 times the average daily flow rate with any one pump out of service. Pump on/off elevations shall be set to achieve 2 to 8 pumping cycles per hour at the average flow rate.
- 3) The power source, voltage and phasing shall be verified before ordering pumps.
- 4) Evaluate the capacity of the receiving sewer main at the point of discharge and downstream to determine that the line can handle the pumped sewer flow.
- 5) The pump station and force main must be sized to accommodate the total basin area that could gravity flow into it.
- 6) The City of Jacksonville reserves the right to require odor control facilities at pump stations.
- 7) All control panels must be weatherproofed and have weatherproof identifying labels attached with stainless steel screws.
- 8) The use of rigid conduit is required.

C. Wetwells:

- 1) Wetwells shall have the interior walls painted in accordance with the technical specifications, [Section 02530-Sanitary Sewer](#).
- 2) Buoyancy shall be considered and flotation of the wetwells shall be prevented with appropriate construction where high groundwater conditions are anticipated.
 - a. **Computations:** Provide buoyancy calculations to the City Public Services Director. Assume water to top of structure and structure is empty except that you may include the weight of the liquid below pump off elevation.
- 3) Surface water shall be directed away from the station pad in all directions.
- 4) Wetwells, and the access road to the site, shall be located a minimum of 3 foot above the 100 year base flood elevation.
- 5) Provide a screened exterior vent to prevent gas entry to either the panel or pump house enclosure.
- 6) Wetwell components shall be located such that normal maintenance and operation of the components can be performed without having to enter the wetwell.

- 7) Seal the electrical conduit running from the wetwell to the control panel to prevent gas entry into panel or pump house enclosure.
- 8) All bolts, mounting brackets, guide rails, pump lift chains, etc. must be stainless steel, sized to support the applicable static and dynamic loads imposed by the equipment. Cable pump lift chains are not permitted.

D. Site (See [standard details 534.01 through 534.02](#)):

- 1) Provide a service head, meter base, service connection, disconnect, area light with photocell.
- 2) A 10-foot wide all weather access road consisting of 8 inches of ABC is to be provided to the station with a turn-a-round area of sufficient size to accommodate turning of City maintenance vehicles. If the lift station easement does not directly abut a publicly dedicated road, a 30 ft. access easement shall be provided.
- 3) Provide an 8-inch thick concrete generator pad (see [standard detail 534.02](#)).
- 4) Unless otherwise allowed by the City Public Services Director, all stations shall be fenced with an 8-foot high galvanized chain link fence with three strands of razor wire across the top. A minimum of a 12-foot or wider rollback gate shall be provided. Depending on the location of the station, the City Public Services Director may require the use of green privacy slats in the fence.
- 5) An area light on breaker, on a separate circuit from the pumps, shall be provided at the station. The light shall be a minimum of 100-watt sodium high-pressure with a minimum clear mounting height (ground to fixture) of 15 feet.
- 6) 10 ft x 10 ft x 8-inch concrete pad for water tank with drain and valve.
- 7) Emergency pump connection with quick connect flange and plug valve.
- 8) A metered potable water source with non-freeze yard hydrant is required, unless approved otherwise by the City Public Services Director. The Non-Freeze Yard Hydrant shall be Clayton Mark model 5451 Lever type, Woodford W-34 (3/4"), Woodford Y-1 (1") frost proof yard hydrant or approved equal.
- 9) Provide a non-freeze shower w/ eyewash and concrete pad.

E. Force Mains

- 1) Force main materials shall minimum conform to the table in paragraph 1.3.3 [G, Collection System Design](#).

- 2) Provide combination air valve air release valves at all high points with differential grade separation of 15 feet or more between high and low points. See **standard detail 534.03**. If not provided in the design, the designer shall provide calculations to prove that a surge relief valve is not needed.
- 3) A plug valve or valve vault shall be placed outside of the pump station.
- 4) Sewer force main valve boxes shall have the valve cap marked SEWER.

End of Section

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