SECTION 3
SANITARY SEWER SYSTEMS

3.1 GENERAL

This Section sets forth the general requirements for design, installation, and testing of sanitary sewer gravity collection, pressure transmission systems, pump stations and low pressure systems. Additional information can be found in Section 1 (Process and Procedures), Section 4 (Standard Details), and Section 5 (Standard Plan Notes) and Section 7 (Technical Specifications).

3.2 SEWER COLLECTION SYSTEM DESIGN

The Engineer shall comply with the design and installation requirements as specified by LCPW, the North Carolina Department of Environment and Natural Resources (NCDEQ), North Carolina Department of Transportation (NCDOT) and any other relevant State and Local regulatory agencies.

A. Flow Demands

Flow demands for design shall be calculated on the basis of full development as known or projected. For phased developments, the design shall be based on total build out conditions for the development, or the anticipated service area of the proposed pump station. The average daily flow shall be calculated using the criteria set forth in North Carolina Administrative Code 15A NCAC 2T .0114.

B. Gravity Sewer Size Computation

Sanitary sewer pipes shall be sized to provide ample capacity for the required peak flow rates. The minimum allowable size for any gravity sewer, other than service connections, shall be 8" in diameter. All gravity sewers pipes shall be designed at slopes providing minimum velocities of not less than 2 fps when flowing full, based on Manning's formula. The following minimum slopes shall be used as a design guideline:

SANITARY SEWER PIPE DIAMETER (inches)	MINIMUM SLOPE (feet per 100ft)
8”	0.40
10”	0.28
12”	0.22
15”	0.15
18”	0.12
21”	0.10
24”	0.08

30”	0.058
91.4	0.046

C. Design Considerations

1. Sanitary gravity sewers shall be installed with straight alignment and grade between manholes with manhole spacing not to exceed 400 feet.

2. Manholes shall be constructed at all changes in size, direction or termination of sanitary sewers. A master manhole must be provided within 25 feet of the wet well at all new pump stations unless otherwise approved by LCPW.

3. Sanitary gravity sewer line size changes shall occur only at manholes.

4. Flow direction changes greater than 90 degrees shall not be allowed without special approval unless a 6 ft diameter manhole is constructed. For flow direction changes greater than or equal to 45 degrees at a manhole, a minimum line drop of 0.1 feet shall be provided across the manhole.

5. Corrosion protection of existing sewer mains and manholes shall be provided when design velocities greater than 6 fps are anticipated or attained.

6. Special attention shall be given to gravity lines which receive flow from sanitary sewer force mains. Care shall be taken in these areas to ensure excessive flow rates do not create surcharge conditions downstream. Manholes within 800 feet downstream of discharge point shall be protected internally from deterioration by a liner system. (See details in Section 4).

7. Service connections shall be installed at the locations shown in the approved drawings and per the standard details shown in Section 4. A minimum of one (1) service connection shall be installed to service every property fronting a gravity sewer line and can be accomplished by a single service lateral for a lot. Service connections shall be a minimum of 4" diameter for single family residential and 6" diameter for commercial facilities. Service connections shall be made into the gravity sewer lines only.

8. Gravity sewer pipes shall have a minimum 4 ft of cover to the top of the pipe.

9. All service laterals shall have a cleanout located at the easement or at the R-O-W line.

10. The materials allowed for buried sewer pipes are polyvinyl chloride (PVC) or ductile iron pipe (DIP). Use of high density polyethylene (HDPE) and fittings are not allowed without the specific approval of LCPW.

11. Protection of Water Supplies – Wastewater sewers proposed in the vicinity of any water supply facilities, shall meet the following requirements from the NCDEQ design criteria set forth in 15A NCAC 02T .0305. Regardless of specified pipe material no vertical separations of less than 12" will be accepted by LCPW.

    a. Horizontal and Vertical Separation

    Sewers shall be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured from outside pipe wall of the sewer pipe to outside pipe wall of the water main. In cases where it is not practical to maintain a 10 foot separation, LCPW may allow deviation on a case-by case basis, if supported by data from the design engineer and approved by NCDEQ. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches above the top of the sewer..

    b. Crossings

    Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The sewer pipe shall cross under the water main unless otherwise approved by LCPW. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to maintain line and grade.

    When it is impossible to obtain proper horizontal and vertical separation as stipulated above, one of the following methods must be specified:

    a. The sewer shall be designed and constructed equal to the requirements water pipe design, and shall be pressure tested at 200 psi to assure water tightness prior to backfilling.

    b. The sewer line shall be encased in a watertight carrier pipe, which extends 10 feet on both sides of the crossing, measured perpendicular to the water main. The carrier pipe shall be of materials meeting the requirements described in later sections.

    The points of beginning and ending of pipe encasement shall be not more than 6" from a pipe joint to protect the pipe from cracking due to uneven settlement of its foundation or the effects of superimposed live loads. The carrier pipe shall be centered on the crossing.

D. Connection To Existing System

Any private wastewater system desiring to connect to Lincoln County's sanitary sewer shall be constructed to LCPW standards and the ownership turned over to LCPW in its entirety. Prior to acceptance by LCPW, this wastewater system shall be tested and inspected by LCPW or its representatives, to assure compliance with LCPW' standards. In no case shall substandard private systems generating excessive inflow/infiltration as determined by LCPW, be allowed to connect into the County's system. Any cost associated with this connection must be paid for by the private system owner and the connection coordinated with LCPW or its representatives.

In no case shall LCPW be responsible or take ownership of any grinder stations that discharge into either a gravity or low pressure sewer system. Private grinder stations shall be the sole responsibility of the owner to maintain up to the connection point as shown in Section 4 (Standard Details).

3.3 GRAVITY SEWER COLLECTION SYSTEM MATERIALS

The following pipe shall be acceptable for sanitary sewer gravity line construction:

A. Ductile Iron Pipe

All gravity sewer mains larger than 12" shall be constructed of Ductile Iron Pipe. Restrained Joint Ductile Iron Pipe shall be used for all vertical deflections, ditch crossings, subaqueous crossings, and all paved surfaces unless otherwise approved by LCPW.

Ductile Iron Pipe between 3" and 4" shall be a minimum of Class 51 meeting AWWA C151. Ductile Iron Pipe 6" and larger shall be a minimum of Class 50. Ductile Iron Pipe shall conform to the requirements of ANSI/AWWA C151, and shall be cement lined and conform to the requirements of ANSI Standard C104. Fittings for Ductile Iron Pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11 and flanged joints shall conform to ANSI/AWWA 115/a21.51.

All aboveground pipe shall be painted green. The pipe wall thickness shall not be less than that required by a working pressure of 250 psi in laying condition Type 4 "B" with 5-foot cover in conformance with ANSI Standard A21.50. Gaskets shall be a Buna N, Neoprene, or a Nitryl-based rubber product approved by the County. Gaskets shall have clean tips unless otherwise specified. Elastomeric gaskets conforming to ASTM F-477 shall also be acceptable.

B. Polyvinyl Chloride Pipe

All polyvinyl chloride pipe (PVC) shall be of the integral bell and spigot joint type which meets or exceeds requirements set forth in ASTM D3034. Minimum wall thickness shall conform to SDR 35. Fittings shall be made of PVC plastic as defined in ASTM D3034. Flexible gasketed joints shall be elastomeric compression types conforming to ASTM F1336, ASTM D3201 and ASTM F477.

C. Manholes

1. Manholes shall conform to the requirements of ASTM Designation C478, with reinforcement of Grade 40 bars and the following modifications:

2. The minimum wall thickness shall be 6".

3. The design of the structure shall include a precast base of not less than 6" in thickness poured monolithically with the bottom section of the manhole walls.

4. Manhole tops shall terminate at such elevations as will permit laying up grade rings under the manhole frame to make allowances for future grade adjustments.

5. Drop connections, where required on precast manholes, shall be manufactured with the manhole elements at the casting yard. Drop manholes shall be constructed per the standard drawings in Section 4.

6. Unless otherwise approved by LCPW, all manholes within 800 feet of low pressure sewer or force main discharge shall be protected internally from deterioration. All manholes, wet wells and valve vaults where high ground water exists shall be internally coated. The Project Engineer is required to submit a plan to LCPW.

   The liner or coating system must be installed per manufacturer's recommendation and completely protect the structure from corrosion. The liner or coating system must extend and seal onto manhole ring, seal onto and around pipe openings, and any other protrusions, completely cover the bench and flow invert. The Contractor must provide a five (5) year unlimited warranty on all workmanship and products. The work which includes the surface preparation and application of the coating or liner system, shall protect the structure for at least five (5) years from all leaks, and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

D. Manhole Frames and Covers

Castings for manhole frames, covers and other items shall conform to the ASTM Designation A48, Class 30. Castings shall be true to pattern in form and dimensions and free of pouring faults and other defects in positions which would impair their strength, or otherwise make them unfit for the service intended. The seating surfaces between frames and covers shall be machined to fit true so the frames and covers do not shift under traffic conditions or permit entry of storm water from flooding. Lifting or "pick" holes shall be provided, but shall not penetrate the cover. The words SANITARY SEWER shall be cast in all manhole covers. All manhole frames and covers shall be traffic bearing unless otherwise specified and conform to U.S. Foundry Casting Specification 240-B. Frames and covers shall be fully bedded in mortar to the correct finish grade elevation with adjustment brick courses or concrete grade rings installed in conformance with the standard drawings in Section 4.

Inflow protectors shall be provided for all manholes that are not adjacent to roadways and part of a cross country system. Plastic or 304 stainless steel inflow protectors and rubber gasketed rims shall be provided for manholes located in non-traffic bearing locations..

LCPW may require secured manhole lids where there is a possibility of unauthorized removal of the manhole cover to drain stormwater into the sewer system, LCPW may require the use of US Foundry 240B-BWT bolted water tight manhole frame which has four (4) stainless steel bolts and a flat gasket or approved equal.

3.4 SEWAGE FORCE MAINS DESIGN

This Section includes the general requirements for design and installation of force main systems serving sewage pumping stations. Additional information can be found in Section 4 (General Information), Section 4 (Standard Drawings), and Section 5 (Standard Plan Notes) and Technical Specifications.

A. <u>Design Standards</u>

1. System Capacity

Force main systems shall be of adequate size, but at minimum 4", to efficiently transmit the total ultimate peak operational flow to the effluent point. Consideration shall be given to possible future connecting pumping stations and this probability shall be reviewed with LCPW. Capacity computations shall be coordinated with the proposed pumping system and future flow requirements, if applicable. In order to provide adequate pipeline cleansing, force main flow velocity shall not be less than 2 fps at minimum pumping capacity, nor greater than 6 fps at ultimate maximum design pumping capacity. However, with multiple pumping station systems or phase development, this minimum velocity requirement may not be possible and the system design shall receive special attention regarding hydrogen sulfide formation and control, and cleaning maintenance such as installation of pressure clean outs.

2. Operational Cost Consideration

   In addition to initial capital expenditure, long-term pumping station operational costs shall also receive consideration when sizing force main systems. Should a pipe size option be available within the design limits, the cost of sewage pumps and motors, force main system and pump operating power (computed for design average daily flow rate for ten (10) years at existing electricity cost), shall be compared to like amounts for the alternate designs. The final force main size selection shall be based on the least long range capital and operational cost. Said cost analysis shall be subject to review and approval by LCPW.

3. Connection at Conflict Structures

   Where pipes are to extend into or through structures, flexible, watertight joints shall be provided at the wall face. Pipes shall be encased throughout the inside of the structure, and there shall be no interior joints.

4. Corrosion Protection

   The allowed force main pipe materials are polyvinyl chloride (PVC), ductile iron (DIP) or high density polyethylene (HDPE) pipe. Any other proposed materials are not allowed without the specific approval of LCPW.

5. Air Venting

   Where the force main profile is such that air pockets or entrapment could occur, provisions for air release shall be provided shall be provided per NCDEQ specifications. Automatic air release assemblies shall be installed on all force mains at profile break points, such as tops of hills, where free flow will occur during operation or after pumping stops. Air release valves shall be suitably housed in a properly vented underground vault, manhole or casting.

6. Valve Locations

   Unless otherwise approved by LCPW, for force mains with diameters larger than 12", valves shall be installed in the force main runs a minimum of every 1,000 feet. Valves shall be installed on all subsidiary force mains at the point of connection to the major main in order to isolate said pipeline for maintenance. Where force mains are to be extended, valves shall be placed at the future connection point to preclude line shutdown at the time of extension. At future connection branches or ends, the valves shall be followed by 2 lengths of pipe and capped and shall be restrained by methods other than thrust blocking in order to facilitate said connection without system shut-down.

7. Clean-Out Connections

   Should force mains appear to be susceptible to sedimentation clogging created by depressed crossings or extended low flow and low velocity periods, suitable clean-out connections shall be provided. Said clean-outs, such as plugged wye shall be located to facilitate the subject maintenance operation.

8. Terminal Discharge

   To minimize turbulence and release of sewer gases, force mains shall enter the terminal facility (gravity sewer manhole or pumping station wet well) at a point just below the operational water level of said receiving unit. At manholes, the point of force main entry shall be in the same direction as the flow line. Any deviation must first be approved by LCPW. Should an elevation drop be required to obtain the outlet connection, the prior down slope of the force main shall not exceed 45 degrees and adequate air venting shall be provided at the profile breakpoint. Force main profile shall be designed so pipe upstream from the breakpoint remains full at all times (see details in Section 4).

   For new force main connections to existing manholes or pump station wet wells, the developer must install a LCPW approved liner/coating system for corrosion protection of the manhole structure and any additional manholes within 800 lf downstream from the receiving manhole. Additionally, for discharge of new force main flow into an existing LCPW pump station wet well, the developer must install a new inline master manhole unless one already exists. Both the master manhole and wet well shall be coated.

9. Identification

   To preclude possible domestic water tapping, all underground gravity sewers and force main pipes shall be green and marked with 3" detectable marking tape for "sanitary sewer" per standards outlined in the Utility Location and Coordinating Council's Uniform Color Code and placed along the entire pipe length. In all cases, the marking detectable tape shall be installed a minimum of 12” to 18" below finished grade during backfill operations and in accordance with the tape manufacturer's specification.

   A location tracing wire shall also be installed with all PVC and HDPE pipe and shall be a continuous No. 10 insulated copper tracing wire laid in the trench on top of the pipe and attached to the pipe at ten (10) foot intervals. This continuous tracing wire shall run along the entire pipe and be stubbed out at valves, pressure clean-outs and air release valves.

10. Depth

Sanitary sewer force mains shall be designed to have 36" of minimum cover.

B. Materials

1. Pipe

The following pipe materials shall be acceptable for force main construction:

Polyvinyl Chloride (PVC) - PVC sanitary sewer force mains shall meet the following AWWA specifications:

- AWWA C900, DR 14 for pipe diameters 4" through 12"
- AWWA C905, DR 18 for pipe diameters 14" through 24"
- AWWA C905 DR 25 for pipe diameters greater than 24".

PVC pipe must not be used in areas with petroleum contamination.

Ductile Iron Pipe (DIP) - DIP sanitary sewer force mains shall meet the following AWWA specifications:

- AWWA C151, Class 51 for push-on and MJ pipe and Class 53 for flanged pipe for pipe diameters 4" through 12"

All DIP and fittings shall be Protecto 401™ lined or equivalent.

High Density Polyethylene (HDPE) – LCPW has the option of approving the use of HDPE sanitary sewer force mains. HDPE force mains shall have the equivalent internal diameter and equivalent pressure class rating as the corresponding PVC pipe, unless otherwise approved by LCPW. HDPE pipe must have at least three equally spaced horizontal green marking stripes.

Air piping and fitting used for transmission of sewer gases in odor control system must be Schedule 40 PVC, fiberglass or HDPE material. DIP pipe and fittings will not be allowed for air piping of sewer gases.

2. Pipe Joints

Pipe joints shall have provisions for expansion and contraction provided in the joints. All joints shall be designed for push-on make-up connections. Push-on joint may be a coupling manufactured as an integral part of the pipe barrel consisting of a thickened section with an expanded bell with a groove to retain a rubber sealing ring of uniform cross section, similar and equal to John's Mannville ring-type and Ethyl Bell Ring or may be made with a separate twin gasketed

coupling similar and equal to Certainteed Fluid-Type. Gaskets shall be elastomeric and conform to AWWA Standards and ASTM F-477.

Gaskets shall have clean tips unless otherwise specified. If petroleum contamination is found or suspected, Buna N (nitrile) gaskets must be used.

3. Inspection of Material

   The Contractor shall obtain from the pipe manufacturers a certificate of inspection to the effect that the pipe and fittings supplied have been inspected at the plant and that they meet the requirements of these specifications. All pipe and fittings shall be subjected to visual inspection at time of delivery and also just before they are lowered into the trench to be laid, and pipe joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor. The entire product of any plant may be rejected when, in the opinion of the Owner, the methods of manufacture fail to secure uniform results, or where the materials used are such as to produce inferior pipe or fittings.

4. Fittings (See Technical Specifications for more details)

   All underground fittings shall be HDPE fittings or AWWA C900 or C905 PVC push on joint, with the minimum pressure rating of 250 psi. DIP fittings must not be used unless specifically approved by LCPW. If approved, DIP fittings must have a factory applied internal fusion bonded epoxy coating to a minimum of 20 mil thickness.

   All above-ground fittings in direct contact with wastewater shall be HDPE or ductile iron flange-joint type with the minimum pressure rating of 250 psi and shall conform to the requirements of ANSI Standard A21.10. Above ground DIP fittings must have an internal fusion bonded epoxy coating to a minimum of 20 mil thickness. All above ground fittings must have a factory applied exterior epoxy coating in accordance with AWWA C550.

   PVC fittings 4 inches and larger in diameter shall meet the requirements of applicable AWWA C900 and C905 specifications. Fittings shall be manufactured entirely of PVC meeting ASTM D1784, shall be formed by a thermal-form process and be of one-piece construction. PVC fittings must be able to withstand 755 psi quick burst pressure-tested in accordance with ASTM D1599 and withstand 500 psi for a minimum of 1,000 hours tested in accordance with ASTM D1598. Bells shall be gasketed push on type conforming to ASTM D3139 with gaskets conforming to ASTM F477. Fittings shall be as manufactured by the Harrington Corporation, or approved equal. Ductile iron fittings with mechanical or push on joints conforming to AWWA C153 or C110 may be approved as alternative when PVC pressure fittings of the required sizes are not available. If approved, DIP fittings must have a factory applied internal a fusion bonded epoxy coating to a minimum of 20 mil thickness.

5. Valves

    a. Eccentric Plug Valves (See Technical Specifications) Only eccentric plug valves are approved for use in sewage applications. The only exception is when wet taps are used to connect to existing force mains.
    b. Swing Check Valves (See Technical Specifications)
    c. Pinch Check Valves (See Technical Specifications)

6. Valve Boxes (See Technical Specifications)

    Cast iron valve boxes shall be provided for all valves installed underground which do not have extended operators such as is required by the plug valves. The valve boxes shall be adjustable to fit the designated depth of each cover over the valve and shall be designed so as to prevent the transmission of surface loads directly to the valve or piping. Valve boxes shall have an interior diameter of not less than 5". The valve boxes shall be provided with covers marked with the word "SEWER". The covers shall be so constructed as to prevent tipping or rattling. Valve boxes shall be manufactured by OPELIKA FOUNDRY COMPANY, Opelika, Alabama or TYLER PIPE DIVISION, Tyler, Texas or approved equal.

7. Air Release Valves (See Technical Specifications)
8. Restraining Devices (See Technical Specifications)

    Restraining joints shall be placed at all bends, tees, plugs, reducers, and other fittings to provide lateral support, and shall conform to the details shown on the drawings in Section 4.

9. Concrete thrust blocks may be utilized.

    Joint restraining systems shall be designed for the maximum pressure condition and the safe bearing load for horizontal and vertical thrust. At a minimum, the thrust restraining system shall have a working pressure equal to or greater than the pipe material maximum pressure rating.

    A reasonable safety factor shall be determined by the Design Engineer in specifying all restraining devices. All restrained fittings and joints shall be shown on the plan and profile and must be included on the record drawings. Refer to Section 4 for the minimum restraint schedule required by LCPW.

    A joint restraining schedule shall be the responsibility of the Design Engineer and shall be included in the design package. The restraining schedule shall be an integral part of the package submitted for approval to LCPW and the permit agencies.

3.5 EXCAVATION, TRENCHING, BACKFILLING AND RESTORATION

A. General

The provisions set forth in this Section shall be applicable to all underground sewer piping installations regardless of location. Special design considerations shall require approval from Lincoln County Utilities.

B. Materials (See Technical Specifications)

All Materials shall be in accordance with AWWA standards and manufactures specifications. See Section 7 Technical Specifications for details.

C. Workmanship (See Technical Specifications)

All Workmanship shall be in accordance with AWWA standards and manufactures specifications. See Section 7 Technical Specifications for details.

3.6 ADDITIONAL INSTALLATION REQUIREMENTS (See Technical Specifications)

A. Flush Out Connections. Flush out connections shall be installed at the locations and in accordance with the details shown in Section 4.

B. Casing Installations

1. General

The provisions of this section shall represent the minimum standards for the installation of casing pipe for sewer force main pipeline.

Sewer force mains to be placed under all North Carolina Department of Transportation & Engineering roadways shall be installed in a casing. The steel casing procedures shall conform to the requirements of NCDOT as outlined in specifications and any supplements thereto. All work and materials shall be subject to inspection by NCDOT. The NCDOT's property and surface conditions shall be restored to the original condition in keeping with the Department's specifications and standards.

In general, all underground sewer force mains crossing all existing North Carolina roadways, North Carolina State Highways and railroads shall be installed under these traffic ways within steel casing pipe. Specific crossing requirements shall be obtained in advance from the authority having jurisdiction.

It shall be the responsibility of the Contractor to submit the necessary permit documents and data to the appropriate authority and receive approval thereof. The Contractor shall maintain traffic on the roadway and shall keep all workmen and

equipment clear of the travel way during the work. All safety regulations of the Department and any permit(s) shall be complied with.

2. Casing Pipe Material and Installation

Casing pipes crossing under County roadways shall be located at suitable approved alignments in order to eliminate possible conflict with existing or future utilities and structures with a minimum 36" depth of cover between the top of the casing pipe and the surface of the roadway. Casings shall be new prime steel pipe conforming to the requirements of ASTM Designation A-139. The minimum casing pipe size and wall thickness shall be as shown in the following table, for the sewer carrier pipe size indicated. For sizes not included therein, or for special design considerations, approval shall be obtained from LCPW.

For PVC Pressure Carrier Pipes

CARRIER PIPE	Casing Pipe	Wall Thickness		Recommended Min. Tunnel
		DOT	RR	
6” Ductile Iron	12”	0.250”	0.281”	48”
8” Ductile Iron	16”	0.250”	0.312”	48”
10” Ductile Iron	16”	0.250”	0.344”	48”
12” Ductile Iron	20”	0.250”	0.375”	48”
16” Ductile Iron	24”	0.312”	0.469”	48”
18” Ductile Iron	30”	0.312”	0.469”	48”
20” Ductile Iron	30”	0.375”	0.501”	48”
24” Ductile Iron	36”	0.375”	0.532”	48”

HDPE Carrier Pipe

HDPE may be used as the carrier pipe and casing pipe with approval from NCDOT and LCPW. The HDPE casing shall be SDR 11 and there shall be a minimum of 4” clearance between the interior of the casing pipe and the outside of the carrier pipe, unless otherwise approved by the County.

For casing pipe crossings under roadways, railroads, or other installations not within the jurisdiction of Lincoln County, the Contractor shall comply with the regulations of said authority in regard to design, specifications and construction. State Highway casing installations shall be as specified by NCDOT. However, in no case shall the minimum casing pipe diameter and wall thickness, for a specific carrier pipe size, be less than that specified above.

3. Carrier Pipe

Sewer Force Mains installed within casing pipes shall utilize joint restraining for the entire pipe length inside the casing. Special supporting of the carrier pipe within the casing shall be required with a design approved by LCPW.

Cascade stainless steel carriers with ultra high molecular weight polyethylene polymer skids, being on center and restrained can be used for installing the carrier pipe. Skids shall be installed 10 feet, or less, on center. After the carrier pipe has been tested for leakage, the casing shall have the ends blocked with either a 8" wall of brick masonry with a weep hole installed near the bottom of each wall or Cascade Model CCES End Seals with stainless steel bands.

High density polyethylene casing spacers or approved equal, can be used for all size PVC carrier pipes. The spacers shall be of a projection type with a minimum number of projections around the circumference totaling the number of carrier pipe diameter inches. Casing spacers shall be spaced per manufacturer's recommendation with double spacers on each end of the casing. The casing spacers shall provide a minimum safety factor of 2 to 1 to support the service load.

C. Testing

All new sewer lines installed shall be tested for leakage. The test used will be Hydrostatic Testing for force mains and Low Pressure Air Testing for gravity lines. Tests to be performed will be indicated by the Engineer and witnessed by the Engineer and the LCPW representatives.

1. Flushing

   All mains shall be flushed to remove all sand and other foreign matter. The velocity of the flushing water shall be at least 2 fps. Flushing shall be terminated at the direction of the Engineer. The Contractor shall dispose of the flushing water without causing a nuisance or property damage.

2. Hydrostatic Testing

   The Contractor shall perform hydrostatic testing of the system as set forth in the following, and shall conduct said tests in the presence of representatives from the County and other authorized agencies, with 72 hours advance notice provided. Piping and appurtenances to be tested shall be within sections between valves unless alternate methods have received prior approval from the County. Testing shall not proceed until concrete thrust blocks are in place and cured, or other restraining devices installed.

   All piping shall be thoroughly cleaned and flushed prior to testing to clear the lines of all foreign matter. While the piping is being filled with water, care shall

be exercised to permit the escape of air from extremities of the test section, with additional release cocks provided if required.

Hydrostatic testing shall be performed with a sustained pressure for a minimum of two (2) hours at 150 psi pressure or 2-1/2 times working pressure, whichever is higher, unless otherwise approved by LCPW, for a period of not less than two (2) hours. Testing shall be in accordance with the applicable provisions as set forth in the most recent edition of AWWA Standard C600. The allowable rate of leakage shall be less than the number of gallons per hour determined by the following formula:

$$L = \frac{SD\,(P)^{0.5}}{133{,}200}$$

Where,

L = Allowable leakage in gallons per hour;
S = Length of pipe tested in feet;
D = Nominal diameter of the pipe in inches;
P = Average test pressure maintained during the leakage test in pounds per square inch

For 150 psi, L = (9.195 EE-5)SD

The testing procedure shall include the continued application of the specified pressure to the test system, for the one hour period, by way of a pump taking supply from a container suitable for measuring water loss. The amount of loss shall be determined by measuring the volume displaced from said container.

Should the test fail, necessary repairs shall be accomplished by the Contractor and the test repeated until results are within the established limits. The Contractor shall furnish the necessary labor, water, pumps, and gauges at specified location(s) and all other items required to conduct the required water distribution system testing and perform necessary repairs.

3. Low Pressure Air Testing of Gravity Sewers

   General

   It is imperative that all sanitary sewers and associated service lines be constructed watertight to prevent infiltration and/or exfiltration. To that end, all new gravity sanitary sewer systems will be subject to low pressure air testing.

Low Pressure Air Test

After completing backfill of a section of gravity sewer line and it allowing 30 days to sit, the Contractor shall, at his expense, conduct a Line Acceptance Test using low pressure air. The test shall be performed using the below stated equipment, according to state procedures and under the supervision of the Engineer and in the presence of a LCPW representative, with 72 hours advanced notice provided.

a. Equipment

    1. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
    2. Pneumatic plugs shall resist internal bracing or blocking.
    3. All air used shall pass through a single control panel.
    4. Three individual hoses shall be used for the following connections:
        a. From control panel to pneumatic plugs for inflation.
        b. From control panel to sealed line for introducing the low pressure air.
        c. From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

b. Procedures

    All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

    After a manhole to manhole reach of pipe has been backfilled and cleaned and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psi. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psi greater than the average back pressure of any ground water that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize.

    After the stabilization period 3.5 psi minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "Acceptable", if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psi (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following table:

Pipe Diameter inches	Minutes
8	4.0
10	5.0
12	5.5
16	7.5
18	8.5
24	11.5

Time in minutes = 0.472 D
D = Diameter of pipe in inches.

In areas where ground water is known to exist, the Contractor shall install capped vertical pipe adjacent to the top of one of the sewer lines. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the Line Acceptance Test, the ground water shall be determined by removing the pipe cap, and a measurement of the height in feet of water over the invert of the pipe shall be taken. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11-1/2 feet, then the added pressure will be 5 psi. This increases the 3.5 psi to 8.5 psi, and the 2.5 psi to 7.5 psi. The allowable drop of one pound and the timing remain the same).

If the installation fails to meet this requirement, the Contractor shall, at his own expense, determine the source of leakage. He shall then repair or replace all defective materials and/or workmanship.

D. Deflection Testing For Gravity Sewers

All polyvinyl chloride and fiberglass sewer pipe shall be subject to deflection testing assuring that the maximum deflection of 5% has not been exceeded. Any pipe failing this test is subject to removal and replacement at the Contractor's expense.

E. Televiewing

All sanitary sewer gravity lines shall be televiewed at the Builder, Developer or Contractor's expense; and a DVD of the subject mains provided prior to acceptance by LCPW. Televiewing may only occur after the stabilized subgrade has been installed and satisfactory density tests have been submitted to LCPW. A LCPW representative must be present during the televiewing. The sewer video inspection shall include rotating the camera lens to inspect the interior of each sewer lateral and joints in main line.

F. Pipe Rounders

The use of pipe rounders is strictly prohibited.

3.7 PUMP STATION SYSTEM DESIGN

The Engineer shall comply with the design and installation requirements as specified by LCPW and the Department of Environmental and Natural Resources.

A. General

For pumping stations with a design peak hour flow of 1000 g.p.m. or less, a minimum of two pump units shall be provided. Where the peak hour design flow exceeds 1000 g.p.m., the wet well, generator, electrical requirements and discharge piping shall be designed to accommodate two additional pumps for a total station capacity of have four (4) pumps. All pump stations shall be designed such that the design peak hour flow can be pumped with the largest pump out of service. The selected sewage pump system shall be capable of pumping the design peak hour flow at the maximum computed system total head requirements. Additionally, final selection shall be based a balance of optimum operational costs, future pumping and ability to utilize the pump in another location for emergency purposes. In no case, shall the maximum or minimum diameter impeller available by the vendor for a particular model be selected.

B. Hydraulic Computations

Head-Capacity curves shall be prepared for the proposed pumping system in order to determine the various operational conditions. A hard copy of the hydraulic computations and if a computerized hydraulic model is used, an electronic copy of the corresponding electronic input and output files shall be submitted to LCPW for approval. Hydraulic computations shall be in accordance with standard engineering formulas with pipe friction loss calculated by Hazen-William's Formula, using a conservative coefficient of friction factor (C) of 110 for all pipes. The following values for "K" coefficients shall be used for minor head loss calculations:

Fitting	Coefficient, K
Plug Valves (Fully Opened)	0.77
Swing Check Valves	2.50
90^0 Bends	0.80
45^0 Bends	0.20
Tees (Straight Run)	0.35
Tees (Branch Run)	1.28
Wyes (Straight Run)	0.30
Wyes (Branch Run)	0.50
Expansion Sudden D2/D1=0.75	0.19
Pipe Exit	1.00

WaterCAD is the computerized hydraulic model preferred by LCPW. Other acceptable hydraulic models are KYPIPE, Cybernet, and H2ONet. Use of other hydraulic models may be approved by LCPW on a case by case basis.

The effect of the proposed pump station on the hydraulic capacity of the existing sewer system must be evaluated prior to LCPW approval for connection of the proposed pump station. A hydraulic analysis must be performed to demonstrate that the increase in wastewater flow from the proposed pump station (1) must not surcharge any existing gravity sewers and (2) must not reduce the design pumping capacity of all manifolded existing pump stations and (3) must not cause the receiving pump station to exceed its design capacity.

For a force main system with only one pump station, the system's head capacity shall be calculated under peak hour flow conditions utilizing one pump running, all pumps running, and other combinations, if applicable.

For a force main system with multiple pumping stations manifolded together, the system head capacity shall be calculated under the maximum static head, i.e. wet well level of the proposed pump station set at the pump off elevation and under peak hour flow conditions, as follows:

a. Design pump station is only station on system running, therefore, utilizing above-stated conditions.
b. All pump stations running with one pump running at each station.
c. With one pump running in the proposed pump station together with a pump running at each of the following number of largest flowing pump stations:

Number of Pump Stations Manifolded on the same Forcemain System	Number of Largest Flowing Pump Stations Running Simultaneously
2	2
3	2
4	3
Greater than 4	Sufficient number of pump stations running to pump at least 60% of the total flow when all pump stations are running

C. Wet Well Design

Wet wells shall provide sufficient space for equipment, required suction pipe submergence and the wet well inside diameter shall not be less than 6 feet, or 4 feet for grinder pump stations.

Low water levels shall be set to provide adequate submergence of pumps and facilities to preclude inlet vortexing and air-binding. In general, the normal operational water level shall provide positive suction head for the pumps. High water alarm shall not exceed an elevation that is 6" below invert elevation of the lowest influent gravity sewer. There shall be a minimum distance of 6.0 feet from influent invert to wet well bottom.

In designing the wet wells, the following three limitations must be observed:

1. One pump running in a duplex pump station must have the capacity to pump the peak hour flow.

2. Under average daily flow conditions, it is desirable to set the pump cycle time to pump out the wet well every 6 to 15 minutes to prevent septic conditions. Pump cycle time is defined as the time required to fill the storage volume in the wet well from the pump "Off" level to the Lead Pump "On" level plus the time required to pump down the wet well to the Pump "Off" level.

   The maximum number of cycles per hour shall be 10 cycles per hour or 6 minutes per cycle. For a duplex pump station, the number of pump starts will be one half of the calculated cycles per hour as a result of pump alternation.

3. Since starting current produces heat, it is recommended that each motor be started no more than 10 times per hour. Under average daily flow conditions, the time for one pump cycle is given by the equation:

$$T_{Avg} = \frac{V_{ww}}{(Q_{DP} - Q_{AI})} + \frac{V_{ww}}{Q_{AI}}$$

   Where:
   T_{Avg} = Time for one pump cycle under average flow conditions (in minutes)
   V_{ww} = Storage volume in the wet well from Lead Pump "On" level to Pump "Off" level (in gallons)
   Q_{DP} = Design pumping rate (gpm)
   Q_{AI} =Average flow into wet well (gpm)

   Under peak hourly flow conditions, the time for one pump cycle is calculated as the pump down rate with zero inflow and then refilling of the wet well at peak hourly flow conditions immediately after the pump shuts off. This will result in maximum cycles per hour for the pump station by the equation:

The time for one pump cycle under peak hourly flow conditions is given by the equation:

$$T_{Peak} = \frac{V_{ww}}{(Q_{DP})} + \frac{V_{ww}}{Q_{PI}}$$

Where:

T_{Peak} = Time for one pump cycle under peak hour flow (in minutes)
V_{ww} = Storage volume in the wet well from Lead Pump "On" level to Pump "Off" level (in gallons)
Q_{DP} = Design pumping rate (gpm)
Q_{PI} = Peak hourly flow into wet well (gpm)

D. Piping Design

Each sewage pump shall have individual piping and, for nonsubmersible-type pumps, suction through a down-turned bell mouth fitting located within the wet well to preclude turbulence and a shutoff valve prior to the pump. Each individual pump discharge pipe shall be equipped with an air release valve, a check valve, followed by a shut-off eccentric plug valve prior to connecting into the station header and force main. All pipes discharging into the wet well shall be designed for submerged discharge below the lead pump "pump-off" level (see Section 4 detailed drawings).

This may be accomplished using a drop pipe connection. The intake pipe shall be designed to prevent pump damage by cavitation at possible extreme pumping rates.

3.8 PUMP STATION GENERAL REQUIREMENTS

A. Site

Pumping Stations shall be installed outside of any road right-of-way and be readily accessible sites, unless otherwise approved by LCPW and shall have adequate area provided for operation and maintenance of facility. A site approximately 6 m x 9.1 m (20' by 30') is generally adequate for duplex submersible pump station facilities. The site shall meet the setback requirements per Lincoln County Planning and Zoning. The site shall be well drained and, unless otherwise approved by LCPW, the wet well top slab and electrical panel must be set at or above the elevation designated by the Federal Insurance Administration as the 100-year FEMA flood water surface elevation. For maintenance purposes, the top of the wet well shall be easily accessible by LCPW vehicles.

Site preparation including pavement and walkways for good all-weather operations, and all required site fencing and landscaping shall be provided in accordance with Lincoln County Planning and Zoning.

B. Structures

Where buildings and/or structures are constructed the following special design considerations shall be made:

1. Combined wet well/drywell pumping station structures shall provide complete separation between wet and dry wells, including their superstructures and chlorine storage rooms. Separation by common-wall construction is acceptable, provided that interconnecting pipes and ducts are designed to preclude co-mingling of fluids or gases.

2. Pumping station structures shall be of adequate size to allow easy access to all operating equipment for service and maintenance.

3. Structural openings shall be provided to facilitate equipment removal including pumps and motors, standby generators, communitors or bar screens and other large items.

4. Well designed stairways shall be provided for dry well access and to the service landings for wet wells when regular inspection or maintenance is required therein.

5. All floor and stairway surfaces within drywell shall be sloped and the pump room floor shall be provided with a small channel against the divider wall leading to a sump containing a submersible sump pump.

6. All access openings, stair wells or other abrupt drops in traffic areas shall be covered or protected by gratings, checkered plate, handrails or other applicable safety devices.

7. Building design shall provide adequate ceiling height and structural considerations and include the installation of initial and future hoisting equipment.

8. A master manhole shall be required when constructing a pump station. This manhole shall have only one effluent pipe to the pump station.

C. Ventilation and Odor Control Facilities

Forced draft mechanical ventilation shall be provided for all below ground dry wells and wet wells where free access is required for operating equipment maintenance and/or inspection. Wet wells for submersible installations or others without free access shall be ventilated with not less than one 10 cm (4") diameter open vent pipe. All vents shall be at least 61 cm (2 feet) above flood levels in flood zones set by FEMA or other competent authority. Ventilation for dry wells may be intermittent at a minimum of 30 complete air changes per hour or continuous at six (6) changes per hour minimum, with additional capacity for equipment heat dissipation if required. In all cases of intermittent ventilation, the blower(s) shall operate when lights are turned on or temperature reaches a preset

level. Wet and dry well ventilation systems shall be independent and shall in no case allow cross-connection between these areas.

Ventilating fans or blowers, ductwork and other appurtenances shall be installed in accordance with the recommendations of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbook on "Heating, Ventilating, and Air-Conditioning Systems and Applications, 1987 or latest edition. Ducts shall be fiberglass or Schedule 40 PVC with white or grey painted coating and labeled with air flow direction arrows.

Odor control equipment shall be required for all wet well air concentrations with expected hydrogen sulfide air concentrations exceeding 10 ppm on the average. Proposed odor control equipment and methods shall be reviewed and approved by LCPW.

Drop pipes as shown in the detailed drawings in Section 4, shall be installed to minimize turbulence and release of sewer gases.

D. Piping Systems

1. Pump Station Piping

   Pump station sanitary sewer piping shall have the same requirements as those for sewage force mains outlined in Section 3, except that Ductile Iron Pipe is required.

2. Potable Water Service

   Copper pipe and fittings with appropriate valves and backflow prevention devices shall be required at pump station facilities (See Section 4 for water service details).

E. Connections At Structures, Wall Pipes and Sleeves

Where pipes are to extend into or through structures from the exterior, flexible connections (mechanical or push-on type joints) shall be provided at the exterior wall face.

For pipes passing through structural walls, wall pipes with water stops shall be installed where the location is below the surface of the ground or at any point where fluid levels will exceed that elevation. Neoprene sleeves with watertight caulking and 316 Series SS stainless steel clamps will be suitable at other locations.

F. Wet well Liners and Coatings

The wet well liners or coatings will be required on all concrete wet wells. The following wet well liners or coatings are LCPW approved:

- GU Liner
- Agru Liner
- IET Coating System

The wet well liners or coatings must be installed, tested and inspected after installation per manufacturer's recommendation. The liner or coating system must extend and seal onto wet well hatch frame, around pipe openings and any other protrusions, to prevent contact of wet well structure with corrosive sewer gases. Where no corrosive conditions are expected in a wet well or manhole, with LCPW specific written approval, the interior of the manhole or wet well may be coated with two (2) coats coal tar epoxy to a minimum thickness of 18 mils.

G. Piping Flexibility

In order to provide for expansion and contraction, differential settlement, or expedite installation and maintenance, flexible connections (flanged coupling adapters, expansion joints, couplings, etc.) shall be provided within flanged piping systems.

H. Supports And Restraining

Special consideration shall be given to the support and restraining for piping systems. This requirement shall also apply to both interior and exterior systems with restraining of flanged pressure piping required where flexible connections are used.

I. Station Water System

All sewage pumping stations shall be provided with a station water system with adequate capacity and pressure for wash-down utilization. Said installation shall include all meters, taps, connections. All fees required shall be paid by the developer/contractor prior to placing the pump station in operation. Said supply shall be completely separated from the potable supply by use of LCPW approved reduced pressure-type back-flow prevention device. Hose bibs and hoses shall be standard commercial sizes and provided at convenient locations to facilitate maintenance with special large capacity units installed for wet well wash down. Water service shall meet the details in Section 4 and shall include a standard frost free yard hydrant.

J. Flow Meters

Indicating, totalizing and recording flow meters shall be provided for all sewage pumping stations with ultimate ratings greater than 1500 g.p.m. or as directed by LCPW.

Meters shall be of the magnetic type with Teflon lining, stainless steel electrodes and ultrasonic cleaning, or the universal venturi type with flanged cast or ductile iron body and bronze throat.

Flow meters shall be designed to record both the peak pumping station capacity and anticipated minimum flows with equally high accuracy. The meters shall be direct reading in gallons per minute, totalizing in million gallons per day and recording on 12" diameter, 24-hour linear charts in gallons per minute. All meters shall also be tied to the Radio Telemetry SCADA System. The flow metering system shall be installed within the pumping station structure, if space is available, or in an exterior protected and drained pit. In all cases, meter by-pass valves and piping shall be provided.

K. Lighting

Sufficient lighting shall be provided for night time emergency work at the pump station site. Provide a 10 foot tall aluminum light pole with 250 watt halogen lamp with a manually controlled on/off switch located inside the pump control panel.

L. Emergency Pump Connections

All sewage pumping stations shall be equipped with bypass pumping connections and a stationary standby power generator in accordance with details in Section 4.

M. Sewage Pumps And Motors

1. General

Sewage pumping units shall be capable of handling raw, unscreened sewage and shall be capable of passing a sphere of at least 3" in diameter. Pumps shall be electric motor driven and of a proven design that has been in sewage service under similar conditions for at least five years. Pumps shall provide the required peak design performance requirements and be suitable for operation within the total hydraulic range of operation without overloading the motors.

2. Submersible Pumps

The pump design shall provide easy removal and replacement for inspection or maintenance purposes without bolts or other fastening to be removed or personnel to enter the wet well.

The units shall be non-clog, mechanical seal, submersible sewage pumps as manufactured by Flygt Corporation or ABS Pumps, Inc. Certified pump curves shall be furnished with the pumps.

a. Pump Design (See Technical Specifications)
b. Pump Construction (See Technical Specifications)
c. Pump Test (See Technical Specifications)
d. Pump Warranty (See Technical Specifications)

N. Pump Motors (See Technical Specifications)
O. Pump Controls (See Technical Specifications)

Each pumping station control system shall include a liquid level controller which shall sense the sewage level in the wet well and provide appropriate signals to the logic circuits to produce the required mode of operation for the pumping facilities. The standard level controls shall be five (5) non-mercury Rotofloats as manufactured by Anchor Scientific Inc. Long Lake, MN, or approved equal. At pump stations where there is a possibility of massive accumulation of floatables, oil and grease that may interfere with the proper operation of the floats, LCPW may require the installation of a bubbler type liquid level control system as manufactured by Digital Control Corporation or LCPW approved equal. All pump stations serving commercial and industrial facilities will be required to have a bubbler type liquid level control system unless otherwise authorized in writing by LCPW.

Any alternative levels sensing and control system must be approved by LCPW. The bubbler type liquid level control system and any alternative levels sensing and control system shall include a high float and a low level float as a back-up system.

P. Variable Speed Pump Control Systems See Technical Specifications
Q. Telemetering System (See Technical Specifications)

All sewage pumping stations shall be equipped with and connected to internet telemetry SCADA equipment. Controllers at the pump stations shall be from Dorsett Technologies.

R. Emergency Generators (See Technical Specifications)

Standby emergency generators shall be installed at all pumping stations unless otherwise approved or directed by LCPW.

Said installation shall be an engine-generator of adequate size to automatically start and operate all pumps required for design flow conditions, lights, controls and other critical items. The engine-generator installation shall be in accordance with all applicable manufacturer's requirements. In order to minimize the noise levels, especially in residential, commercial and industrial areas, the generator system must be equipped with a noise reduction package that must first be approved by LCPW. The preferred fuel is natural gas where available. If natural gas is not available diesel generators will be utilized with a fuel capacity capable of running the station under 50% load for 72 hours. At the time of turn over the contractor shall provide a full tank of fuel.

S. Power Disconnect Switch

Pump stations shall be provided with a separate power disconnect switch located in line immediately after the power meter and before the control panel. The switch shall be NEMA 4X, aluminum or stainless steel, housing fitted with locking hoop and padlocks, master keyed to County Standard.

T. Power Meter

The power meter shall be supplied in a NEMA 4X enclosure.

U. Junction Box

Pump stations shall be equipped with a junction box that is adjacent to the wetwell and directly in line with the control panel. The junction box enclosure shall be NEMA 4X, aluminum or stainless steel, housing fitted with locking hoop and padlocks, master keyed to County Standard. Installation shall meet all NFPA 70, ANSI and any other applicable federal state and local codes.

3.9 TYPES OF PUMPING STATION CONSTRUCTION

A. Submersible Facilities

Sewage pumping stations of the submersible type shall include the removable pump units previously specified, aluminum access frame and cover, 316 Series stainless steel pipe pump guide bars. Pump discharge pipes shall extend from each pump to an accessible well protected and drained pit in which the control and check valve, and pressure sensors shall be installed. The submersible pumping system and accessories shall be as manufactured by Flygt Corporation, or ABS Pumps. For flows in excess of 1,000 g.p.m., three (3) or more pumps may be required.

B. Built-In-Place Facilities

Structural built-in-place sewage pumping stations shall be constructed where the peak design flow exceeds 2000 g.p.m. or as directed by LCPW. Additionally, where the peak flow requirement is more than 2000 g.p.m., the facility shall be designed for three (3) or more pumping units. Said facilities shall be constructed in accordance with all applicable provisions of this standard.

C. Wet Wells and Valve Vaults

The structure may be of circular or rectangular design and shall be constructed of poured-in-place or precast, Type II concrete sections (ASTM C-478) placed on a poured bottom foundation base. Fiberglass wet wells may be approved by LCPW on a case by case basis. The top slab shall be suitable for AASHTO H20 traffic loading, and care shall be taken to prevent flotation. All structures shall be constructed level and plumb. Wet wells

shall not be out of plumb by more than 5 cm (2") per 3 m (10') or 1.66%. All wet wells shall be protected from deterioration as specified in previous sections.

The top slab of the wet well and valve vault must be set at an elevation equal to or greater than the 100 year flood elevation. Both valve vault and wet well shall be secured by a fence. (See Section 4 for details)

3.10 PUMP STATION ELECTRIC PANELS

Electric panels shall be of the type recommended by the pump manufacturer and shall be compatible with the requirements of the pumping operation. All panels shall include provisions for turning pumps on and off, manually and automatically, alternating lead pump with each pump cycle or manually, indications for operation and alarm conditions, testing and indication of all operational features, and terminal strip wired and indicated for all telemetry contacts. A minimum of 8 terminal strip contacts shall be provided to allow for expansion, repair or alterations.

For all pump stations operating on 480 V, install appropriately sized transformer to step down the voltage to 120V to provide a minimum of 20 amp circuit in the receptacle.

A waterproof wiring schematic showing the color coded wiring and corresponding descriptions shall be affixed to the inside of the pump control panel door.

Include a lighting arrestor, GE or equivalent, sized for voltage, current and phase for particular installation as approved by a licensed electrical engineer and mounted on the outside bottom of the disconnect box.

All electrical control panels and associated electric panels must meet the requirements of NFPA – 70E and IEEE Std-1584-2018 (Latest Edition) for labeling associated with ARC Flash, Available Voltage, and other electrical dangers.

All wiring shall be color coded and numbered as shown in Section 4.