SECTION IV - TESTS AND INSPECTIONS

PART 1 - GENERAL

1.01 Testing - General

Testing shall be of the type and frequency described in each section and summarized in Item 1 of this section. In addition to specifically required tests, the City Engineer or SRU Inspector may require all and as many tests as deemed necessary to ensure that the materials and workmanship meet the requirements of the standards and specifications.

All tests shall be scheduled in accordance with the schedule listed in these specifications and the appropriate party informed so if desired, a representative may be sent to watch the test.

All means and apparatus necessary to complete the tests including pumps, gauges, meters, plugs, caps, blocking materials and water shall be provided at no expense to the City.

The City shall incur no costs for tests, including additional testing required by the City Engineer or SRU Inspector to ensure the quality of questionable work or materials.

The cost of any work necessary to bring work failing any test into conformance and retesting shall be done with no cost to the City.

1.02 Test Results

The Contractor/Owner is responsible for obtaining all required tests, reviewing the results and ensuring that all work not in conformance is corrected or replaced. The Inspector shall be copied on all test results. The Contractor/Owner shall keep records and results of all tests, including tests on failed work which has been corrected through the warranty period. At the end of the job, prior to acceptance by the City, the Contractor shall submit a notarized statement certifying that he has reviewed the test results and that all test results were acceptable and/or he has corrected any deficiencies. This certification shall be made by an officer or principal of the company, and shall be in the following form:

> I, (name) (title) of (company) certify that on (name of job) testing has been done in accordance with the specifications and standards of the City of Salisbury's Manual of Standards and that I have reviewed those test results and repaired, corrected, or replaced any work not passing the required test.

1.03 Water and Sewer Inspections/Certifications

At no expense to the City, a North Carolina registered engineer, or his representative, shall be employed to inspect the installation of water (including private fire lines), sewer, drainage, and streets. Inspection should be of the amount and degree required for the engineer to complete the job certification(s) required by the City of Salisbury and State agencies.

1.04 Drainage and Flushing of Mains

Water lines shall be drained through hydrants or blow-offs to natural drains. Sanitary sewers shall be drained to a plugged manhole and then pumped out (new construction). Storm drains shall be drained to the discharge. Drainage of lines will be accomplished in such a manner as to minimize erosion and siltation to adjoining properties. Water velocity from drainage and/or blow-off will also be dissipated in an acceptable manner to protect the environment. Chlorinated water shall be handled as described in the sterilization section.

Hydrants or blow-offs shall not be connected to any sewer, submerged in any streams, or installed in any other manner that will permit back siphonage into the distribution system. An approved backflow prevention device and a bulk water permit are required for any fire hydrant use.

1.05 Water Use

Water used for testing, flushing, disinfection, etc., may be purchased from the City at prevailing rates (bulk water permit required). The use of water (time and quantity) shall be coordinated with the SRU Inspector. Sources other than City water may be used if approved by the SRU Inspector. A City of Salisbury approved (jumper) backflow device (RP) must be used when water is obtained from existing water main (existing water line to new water line). When a fire hydrant is used to supply water for flushing, testing, etc. a City of Salisbury approved backflow device (RP) must be used on the fire hydrant to prevent any possible backflow to the City's water system.

1.06 Schedule of Tests and Notifications

Item	Minimum Advance Frequency	City Presence Required	Minimum Notice (*4)
WATER			
Backfill	see Section IV-Item 2.01	no (*5)	2 hours
Flushing (*1)	at end of construction(*2)	no	24 hours
Pressure Testing (*1)	at end of construction	yes	48 hours
Sterilization (*1) lab confirmation of free chlorine level	at end of construction	yes	24 hours
bacteriological testing (lab)	at end of construction 8:00 a.m. to 12:00 p.m. Mon. - Thurs.	yes	24 hours
SANITARY SEWER GRAVITY			
Backfill	see Section IV-Item 3.01	no	1 hour
Flushing (*1)	at end of construction (*2)	no	24 hours
CCTV Inspection (*3)	at end of construction	yes	48 hours
Air Test (*1)	at end of construction	yes	48 hours
Deflection	no sooner than 30 days after final backfill	yes	48 hours
MH Vacuum Testing	during or at end of Construction	yes	48 hours
Compaction Testing	as required by SRU Inspector/City Engineer	yes	24 hours

Item	Minimum Advance Frequency	City Presence Required	Minimum Notice (*4)
SANITARY SEWER FORCE MAIN			
Backfill	see Section IV-Item 3.06	no (*5)	2 hours
Flushing (*1)	at end of construction(*2)	no	1 hour
Pressure Testing	at end of construction	yes	48 hours
STORM LINES			
Backfill	see Section IV-Item 4.01	no	1 hour
Flushing (*1)	"	no	1 hour
ROADS			
Soils Borings	see Section IV-Item 5.01	no	24 hours
Compaction (*6)	see Section IV-Item 5.02	yes	24 hours
Concrete	see Section IV-Item 5.04	yes	24 hours
Proof Rolling	see Section IV-Item 5.05	yes	24 hours

*1 - Schedule of water use, including estimate of amount, rate, day, time and duration must be filed ten (10) days prior to need. Water use is subject to City approval and at prevailing rates. A bulk water permit is required for water use.

*2 - Or as scheduled with the SRU Inspector.

*3 - As directed by SRU Inspector.

*4 - Minimum notice - Subject to the availability of a SRU Inspector

*5 - Unless required by the SRU Inspector.

*6 - Compaction testing may be required by City Engineer or SRU Inspector.

1.07 Concrete Testing-General

When required, quality control and testing of concrete and constituent materials shall be carried out in accordance with specifications of NCDOT. The Owner/Developer shall make necessary arrangements and pay for all expenses in connection with these tests.

The Owner/Developer or their Contractor, in conjunction with the City's project representative, shall be responsible for scheduling the testing firm's personnel to be on site as required for concrete testing.

1.08 Supplier Tests

Concrete shall be obtained from a reputable supplier, approved by the City. The concrete supplier shall have made tests of aggregate soundness per ASTM C88 and C33 and sieve analysis of fine and coarse aggregate per ASTM C136 within the six months prior to supplying concrete to the job. Certified results of these tests shall be made available to the City upon request.

SECTION IV - TESTS AND INSPECTIONS

PART 2 - WATER

2.01 Backfill

Backfill shall be tested by an independent testing laboratory approved by the City. Tests shall be performed in accordance with ASTM methods and be appropriate to the soil type. The backfill in pipeline trenches shall be tested at a minimum as follows:

Pipelines within the road right-of-way, existing or proposed roads. Test density every 12-inches (2 lifts) of placed backfill at intervals of 100 or 200 feet, minimum one per day. The SRU Inspector may require compaction testing every 100 feet when sewer is being placed within existing or proposed roads. The SRU Inspector may also require additional compaction testing whenever the contractor is not adhering to the City's compaction/backfilling standards and when bad soil is present. The compaction tests shall be done at no cost to the City or SRU.

Pipeline under lawns or cross-country: Test density every 12-inches (2 lifts) of placed backfill at intervals of 500 feet, minimum one per day.

2.02 Flushing

At completion of work, lines shall be thoroughly cleaned by flushing potable water to remove all dirt and debris. Pipeline shall be flushed at a rate of at least 2.5 feet per second for a duration suitable to the SRU Inspector. Water that is used for flushing (water lines) that has not been treated (chlorinated) by the contractor may be discharged into the storm drain.

2.03 Pressure / Leakage Test

General

All water lines shall be pressure tested. Pressure testing must be done prior to chlorination of the water lines.

Tests shall be conducted on a schedule agreed upon by the SRU Inspector, Engineer or Engineer's representative and the Contractor. City inspection is required during the tests with a minimum 48 hour notice (2 business days).

Water services (tap, service line, and meter setter) shall be installed prior to water line testing.

The pipe shall be filled with potable water for a period of 24 hours before testing begins. It shall be ensured that the pipe is full of water and all air has been removed before testing. Contractor shall pretest the water line prior to scheduling a test with Engineer and SRU Inspector.

The water line shall be tested at 1.25 times the highest working pressure along the section, or 200 psig, whichever is greater. The test shall be of at least 2 hours duration and the pressure may not drop more than 5 psig during the test. All exposed pipe, fittings, valves and hydrants shall be

visually examined during the test. Leakage shall be no greater than the amount determined by the formula:

$$L = \frac{SD\,(P)^{1/2}}{148{,}000}$$

where L = allowable leakage (gallons/hour)
S = length of pipe in test (feet)
D = nominal pipe diameter (inches)
P = average test pressure (psig)

Pipe having more than allowed leakage shall be repaired. All visible leaks shall be repaired regardless of the amount of leakage.

A water line allowable leakage test may be allowed if the contractor cannot pass the required pressure test. The contractor must make every effort to get the water line to pass the pressure test before an allowable leakage test will be allowed. The SRU Inspector/SRU Management will determine if an allowable leakage test will be allowed**.**

If the pressure drops 5 psig during the test, the water line shall be pumped back up to testing pressure and the water usage shall be recorded. At the end of the test (two hours), the total water usage must be equal to or less than the allowable leakage. If the total amount of water used to pump the line back up is more than the calculated allowable leakage, the test fails.

If the allowable leakage test fails, the contractor shall find and repair all leaks before another test will be allowed.

A Badger E-Series Ultrasonic water meter in proper working condition shall be supplied by the contractor in order to conduct an allowable leakage test. In lieu of the Badger water meter an accurately/precision graduated mixing bucket, laboratory quality graduated container, or equal type measuring container marked in gallons and quarts or quarts and pints may be allowed. For long water lines, a marked mixing barrel or tank may be required. The SRU Inspector must approve the use of all measuring containers.

Special Testing Requirements for Muncipex® (Pex "A") Pipe

1. Perform a preliminary pressure test pressurizing the lines to 1.5 times the maximum operating pressure, not to exceed the maximum pressures defined above for 30 minutes (165 psig).

2. During the 30 minute preliminary test, as the piping expands (pressure may not drop more than 5 psi), restore the pressure (165 psig), first at 10 minutes into the test and again at 20 minutes.

3. After performing the preliminary test, perform the main pressure test immediately. The main pressure test shall last at least 2 hours. The test pressure should be restored (150-165 psig) and must not fall more than 3 psig after 2 hours. No leakage should be detected.

2.04 Valves

Valves shall be field tested as directed by AWWA Specification C500 and C504 as applicable.

(a) During the last stages of the test and without any reduction in pressure, first the hydrant valves will be closed, then progressing in an orderly manner from the end opposite from the test pump, each main line valve will be closed and pressure released to determine if it is holding pressure (minimum 30 minutes).

(b) All butterfly valves will be tested to 150 psi (or 1.25 times system pressure, if higher) for a minimum of 30 minutes (each) after the pipeline has been successfully tested.

Valves shall be tested on a schedule agreed upon by the SRU Inspector and the Contractor. City inspection is required during the tests.

2.05 Sterilization

The water lines must be pressure tested prior to chlorination/sterilization**.** Sampling taps shall be provided every 1,000 feet, at the end of each branch, at stub-outs larger than 2" and longer than 4', at every blow-off, and as required by SRU management. Taps shall be located and constructed so samples may be easily collected without danger to personnel or likelihood of sample contamination.

Sampling taps may be used as blow-offs (provided they are properly sized – see standard detail W-13). The number and location of the taps/blow-offs must be approved by the SRU Inspector. Hydrants may not be used for bacteriological sampling.

All parts of a potable water system (including service lines) shall be sterilized in accordance with AWWA C601 and these specifications. Preventive and corrective measures during construction (AWWA C601) should be adhered to during construction to ensure success of the sterilization process.

Lines shall be initially chlorinated to 100 mg/l.

Lines must have a minimum free chlorine residual of 24 mg/l after 24 hours.

When the Contractor has determined that the line has been chlorinated to the proper level, he shall request a laboratory confirmation of the free chlorine level. Advance notice shall be given to the SRU Inspector prior to requesting sampling for chlorine level concentration (on site test) as required in Section 1.80 - Inspection.

After the required contact time (24 hours), the Contractor shall have the chlorine residual tested and if the chlorine levels are at least 24 mg/l then the contractor can flush the line and all appurtenances with Salisbury distribution water until completely purged.

No bacteriological samples will be collected at points where the free chlorine residual exceeds the ambient distribution system free residual by more than 0.5 mg/l.

Care must be taken to discharge the chlorinated water in a manner which will not endanger plant or animal life or be unsafe. Chlorinated water must be discharged in an environmentally safe manner and in accordance with all federal, state, and/or local laws and regulations. Chlorinated sterilization water shall not be discharged into the City's sewer or storm drain systems. Contractor must treat the chlorinated water to meet North Carolina Quality Discharge Standards.

Bacteriological testing/sampling shall be requested on the same day the line is flushed. Bacteriological testing will be performed by the City laboratory Monday through Thursday prior to 12:00 p.m. at least 24 hour notice shall be given the SRU Inspector/lab prior to sampling. The SRU Inspector will collect and deliver the samples to the lab (testing fee applies).

Each sample shall be marked legibly, identifying with letters or numbers each sampling point.

SECTION IV - TESTS AND INSPECTIONS

PART 3 - SEWER

3.01 Backfill

Backfill shall be tested by an independent testing laboratory approved in advance by the City. Tests shall be performed in accordance with ASTM methods and be appropriate to the soil type. The backfill in pipeline trenches shall be tested at a minimum as follows:

Pipelines within the road right-of-way, existing or proposed roads: Test density every 12-inches (2 lifts) of placed backfill at intervals of 100 or 200 feet, minimum one per day. The SRU Inspector may require compaction testing every 100 feet when sewer is being placed within existing or proposed roads. The SRU Inspector may also require additional compaction testing whenever the contractor is not adhering to the City's compaction/backfilling standards and when bad soil is present. The compaction tests shall be done at no cost to the City or SRU.

Pipeline under lawns or cross-country: Test density every 12-inches (2 lifts) of placed backfill at intervals of 500 feet, minimum one per day.

3.02 Flushing

At completion of work, lines shall be thoroughly cleaned by flushing with water to remove all dirt and debris. Pipeline shall be flushed at a rate of at least 2.5 feet per second for a duration suitable to the SRU Inspector. City water may be used (when available and a bulk water permit is purchased) to flush sewer lines or an approved source of non-potable water (must be free of any chemicals, silt, or debris) may be used to flush sewer lines. All flush water must be collected in a plugged manhole and pumped out. Sewer flush water shall not be allowed to enter the City's sewer system.

3.03 Obstructions/Visual Inspection

The pipe shall be visually inspected from manhole to manhole using lights, mirrors, or other devices (CCTV) for visual inspection. All obstructions shall be removed, and the lines from one manhole to the next shall exhibit a fully circular pattern. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet specifications. The SRU Inspector may require inspection by television camera (CCTV) of any sewer lines or laterals.

The CCTV equipment must provide adequate light for the camera and be of high video quality (including the flash drive/thumb drive or DVD) to properly show the inside of the pipe. Each line and lateral must be marked with an identifying number and shown on the flash drive/thumb drive or DVD and a log of any problems found, along with the line number and footage and/or lateral number must be included with the flash drive/thumb drive or DVD. All testing shall be done at no cost to the City.

3.04 Leakage

Leakage tests shall be conducted on a schedule agreed upon by the SRU Inspector, Engineer, and the Contractor. Engineer or the engineer's designated representative must be on site for all required testing. City inspection is required during leakage tests.

Low pressure air testing shall be used to test for leakage in sewer lines and laterals. The test shall be in accordance with ASTM F 1417 as modified herein. The pipeline is considered acceptable if when tested at a pressure of 4.0 psi (or greater than the average back pressure of any groundwater that may submerge the pipe) the section under test does not lose more than 0.5 psig within the allotted test time (see appendix B). City inspection of the test is required.

3.05 Deflection Test

No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using a rigid "Go-No/Go" (mandrel) device. The mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of pipe depending on which is specified in the ASTM Specification, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices. Vertical deflection shall not exceed 5% of the inside pipe diameter. Pipe exceeding the allowable limit shall be repaired and retested. Engineer or the engineer's designated representative must be on site for all required testing. City inspection of the test is required.

3.06 Manhole Vacuum Test

All testing shall be performed in the presence of the engineer or designated representative. Every manhole shall be checked for air tightness prior to setting of the manhole ring and cover. All manholes, whether with precast base sections or poured-in-place base, shall be vacuum tested. All lift holes shall be plugged with a non-shrink grout. All pipes entering or leaving the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole during the test. City inspection of the test is required with a 48 hour minimum notice. All manholes regardless of sewer line size (public or private) shall be tested and inspected to City of Salisbury Uniform Construction Standards and Specifications requirements.

1. The vacuum equipment test head shall be placed at the inside of the top of the cone section, the seal inflated in accordance with the manufacture's recommendations.
2. A vacuum of 10-inches of mercury shall be drawn and the vacuum pump shut off.
3. With the valves closed, the time shall be measured for the vacuum to drop to 9-inches of mercury. The test time shall be correlated to the manhole as follows:

   Manhole Diameter Allowable Time:

   48"…….60 seconds

   60"…….75 seconds

4. If the manhole fails the initial test, necessary repairs shall be made at the contractor's expense with an approved non-shrink grout on the outside of the manhole while the vacuum is being drawn.
5. The re-testing and repairing schedule cycle shall continue until the manhole passes the test.

SECTION IV - TESTS AND INSPECTIONS

PART 3 - SANITARY SEWER FORCE MAINS

3.07 Backfill

Backfill shall be tested by an independent testing laboratory approved by the City. Tests shall be performed in accordance with ASTM methods and be appropriate to the soil type. The backfill in pipeline trenches shall be tested at a minimum as follows:

Pipelines within the road right-of-way, existing or proposed roads: Test density every 12-inches (2 lifts) of placed backfill at intervals of 100 or 200 feet, minimum one per day. The SRU Inspector may require compaction testing every 100 feet when sewer is being placed within existing or proposed roads. The SRU Inspector may also require additional compaction testing whenever the contractor is not adhering to the City's compaction/backfilling standards and when bad soil is present. The compaction tests shall be done at no cost to the City or SRU.

Pipeline under lawns or cross-country: Test density every 12-inches (2 lifts) of placed backfill at intervals of 500 feet, minimum one per day.

3.08 Flushing

Force main lines shall be flushed in the same manner as gravity lines.

3.09 Pressure / Leakage Test

The force main shall be tested for leakage.

The pipe shall be filled with water for a period of 24 hours before testing begins. It shall be ensured that the pipe is full of water and all air has been removed before testing. Contractor shall pre-test the force main prior to scheduling a test with Engineer and SRU Inspector.

The force main shall be tested at 1.25 times the highest working pressure along the section, or 100 psig, whichever is greater. The test shall be of at least 2 hours duration and the pressure may not drop more than 5 psig during the test. All exposed pipe, fittings and valves shall be visually examined during the test. Leakage shall be no greater than the amount determined by the formula:

$$L = \frac{SD\,(P)^{1/2}}{148{,}000}$$

where L = allowable leakage (gallons/hour)
S = length of pipe in test (feet)
D = nominal pipe diameter (inches)
P = average test pressure (psig)

Pipe having more than allowed leakage shall be repaired. All visible leaks shall be repaired regardless of the amount of leakage.

If the pressure drops 5 psig during the test, the sewer line shall be pumped back up to testing pressure and the water usage shall be recorded. At the end of the test (two hours); the total water usage must be equal to or less than the allowable leakage. If the total amount of water used to pump the line back up is more than the calculated allowable leakage, the test fails.

If the allowable leakage test fails, the contractor shall find and repair all leaks before another test will be allowed.

If the sewer line fails multiple pressure loss tests, the SRU Inspector may allow just the allowable leakage test to be performed.

A Badger E-Series Ultrasonic water meter in proper working condition shall be supplied by the contractor in order to conduct an allowable leakage test. In lieu of the Badger water meter an accurately/precision graduated mixing bucket, laboratory quality graduated container, or equal type measuring container marked in gallons and quarts or quarts and pints may be allowed. For long pipe lines, a marked mixing barrel or tank may be required. The SRU Inspector must approve the use of all measuring containers.

Leakage tests shall be conducted on a schedule agreed upon by the SRU Inspector, Engineer, and the Contractor. Engineer or the engineer's designated representative must be on site for all required testing. SRU inspection is required during the tests.

SECTION IV - TESTS AND INSPECTIONS

PART 4 - DRAINAGE

4.01 Backfill

Backfill shall be tested by an independent testing laboratory approved by the City. Tests shall be performed in accordance with ASTM methods and be appropriate to the soil type. The backfill in pipeline trenches shall be tested at a minimum as follows:

Pipelines within the road right-of-way, existing or proposed roads: Test density every 12-inches (2 lifts) of placed backfill at intervals of 200 feet, minimum one per day.

Pipeline under lawns or cross-country: Test density every 12-inches (2 lifts) of placed backfill at intervals of 500 feet, minimum one per day.

4.02 Flushing

At completion of work, lines shall be thoroughly cleaned by flushing with water to remove all dirt and debris. An approved source of non-potable water may be used to flush storm drainage lines, however, a method to keep silt and debris from entering the pipe must be demonstrated and approved.

4.03 Visual Inspection

Lines shall be inspected by visual inspection using appropriate light source checking for misalignment or blockage.

Any pipe not laid true to line and grade shall be repaired. Any blockage or obstructions shall be cleared.

SECTION IV - TESTS AND INSPECTIONS

PART 5 - ROADS

5.01 Soil Borings

Prior to final approval of street design, a report and recommendation from an approved soils testing firm must be submitted. Soil investigation shall include, at a minimum, test bores or test pits located 300 feet apart and in all sump locations. Test bores shall be located at the approximate street centerline and be to a depth of 8 feet below finished grade, or to auger refusal. If auger refusal is encountered, an offset bore will be made to further determine extent of rock.

5.02 Compaction Tests

Fill - Fill in the roadway shall be tested by an independent testing laboratory approved by the City. Tests shall be performed in accordance with ASTM methods and be appropriate to the soil type. Density shall be tested every 2 lifts (12-inches) of placed backfill at intervals of one per 300 feet, minimum one per day.

Base - Density of the base course shall be tested by an independent testing laboratory approved by the City. Tests shall be in accordance with ASTM methods and performed every 300 feet of roadway. At least one test per day shall be performed.

5.03 Marshall Tests of Asphalt Pavement

The Marshall method of testing density shall be performed at frequency required for the owner/developer and/or contractor to determine that specifications for pavement density are being met.

The City may require additional testing if there is reason to believe that minimum densities are not being met.

5.04 Concrete Tests

All concrete used in roadway construction shall be tested in accordance with Part 2 of this section.

5.05 Proof Rolling

All roadway areas shall be proof rolled in the presence of a City Inspector. The travel lane shall be proof rolled on two occasions, first, when the roadbed has been completed to within 0.5 feet of finished grade, before the stone is placed and, second, when the stone is in place and compacted.

On each occasion, each travel lane shall be traversed one time, or as required by the Inspector, with a pneumatic tired roller, or approved single axle vehicle of 10 to 12 tons such as a loaded dump truck or a loaded water truck. The equipment shall be operated at 2 to 4 mph. Where the presence of utility valves, manholes, or other obstructions prevent proof rolling a section of travel lane,

compaction testing may be required at the discretion of the SRU or City Inspector. The compaction testing shall be done at no cost to the City.

If it becomes necessary to take corrective action, such as but not limited to underdrain installation, undercut and backfill of unsuitable material, and aeration of excessively wet material in areas that have been proof rolled, these areas shall be proof rolled again following the completion of the necessary corrections.