City of Lawrence

Water & Sewer Design & Construction Standards

Unit IV – Design and Construction of Sanitary Sewers

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SECTION 1

INTRODUCTION

1.01 GENERAL

The City of Lawrence Utilities (LU) is responsible for the issuance of local construction permits for the installation of all sanitary sewer facilities constructed in the City of Lawrence Sanitary Collection District. The developer is responsible to ensure that all proper submittal for sanitary sewer construction permits are submitted to IDEM for approval. A copy of all documents submitted to IDEM for sanitary sewer permitting shall be provided to the utility at time of submittal. Sanitary sewer facilities shall be designed and constructed in accordance with these Standards, Ten States Standards for Sewage Works and the Indiana Administrative Codes.

These Standards set forth the minimum criteria for the design and all work in connection with the construction of sanitary sewers within the jurisdiction of the City of Lawrence including the entire sewage system and its appurtenances from the point of connection with the building plumbing to the discharge point to the East Marion County Regional Interceptor Sewer. The City of Lawrence Municipal Code, Title 5, Article 1 shall be considered a part of these standards. All plans, profiles, cut sheets, easement documents and specifications shall conform to the standards and requirements herein established. Addenda and/or revisions to these Standards may be issued periodically and will be made available on the utilities website, which may be accessed through the home page for the City of Lawrence. Users of these specifications are urged to review the latest revisions or editions to these Standards to apprise themselves of any changes or revisions. Any questions or concerns should be addressed to utility management as soon as possible.

Where the requirements of another jurisdictional authority having influence on work outside the purview of the City of Lawrence are greater than that provided by these Standards, the work shall conform to the greater requirement of that respective jurisdictional authority.

The Owners of affected property shall be responsible for procuring all necessary permits and licenses, paying all charges and fees, acquiring and recording all easements and giving all notice necessary and incident to the work.

SECTION 2

GENERAL DESIGN STANDARDS

2.01 GENERAL

Construction permits shall be obtained from the LU for the installation of all sanitary sewer facilities discharging into the City of Lawrence Sanitary District. Sanitary sewer facilities shall be designed and installed in accordance with the Standards for Sanitary Sewer Design and Construction in the City of Lawrence Municipal Code, Title 5, Article 1, the Ten States Standards for Sewage Works, and Article 327 IAC 3 of the Indiana Administrative Code.

2.02 DESIGN CRITERIA

A. General

All sanitary sewers shall be designed to carry the estimated flow from the area ultimately contributing to the respective reach of the sanitary sewer. The required capacity shall either be established by the LU or at the LU's option, by means of a basin study developed by the Owner or his authorized representative engineer/designer. In no instance shall a gravity sewer, other than a building sewer, be less than eight (8) inches in diameter.

The following design standards for gravity sewers within or contributing to the City of Lawrence Sanitary District have been established.

1. Population Density

   Population density shall be in accordance with the Comprehensive Plan for Marion County projected by the Division of Planning for the Department of Metropolitan Development, or actual count or character of proposed development, whichever is greatest.

2. Average Family

   For the purpose of design, the average family unit is considered to be 3.5 persons per single family home.

3. Design Flow

   The design of all sanitary sewer facilities shall be based on future area population growth and land development characteristics and figures provided by the City of Lawrence and the LU including the servicing of existing contiguous developed areas not currently served by sanitary sewers. The values of Average and Peak Flow and Design Population shall be the values that include the future flows and population. The LU reserves the right to review and determine the appropriateness/applicability of the estimated flow volumes provided.

   The following shall be used as a guide:

   a. Average Design Flows

- Single Family Residential: The average design flow for single-family homes shall be 310 gpd/unit. The average design flow for a single family development shall be calculated per Article 327 IAC 3-6-11 of the Indiana Administrative Code as follows:

Average Flow (ADF) = General Average Daily Flow x PRSC

Where PRSC is equal to the proposed number of residential service connections.

- Commercial/Industrial/Institutional: The average daily design flow for these facilities shall be based on Article 327 IAC 3-6-11.

This bulletin shall be used as a general guideline in determining average flow volumes anticipated from a proposed development. Based upon information either submitted by the Owner or developed by the LU, these flow volume guidelines may be modified at the LU's discretion.

b. Peak Design Flows

- Single Family Residential: The peak design flow for a single-family development shall be calculated per Article 327 IAC 3-6-11 as follows:

Peak Flow (PDF) = ADF x PF

Where PF is equal to the peak daily factor of four (4).

- Commercial/Industrial/Institutional: The peak design flows from commercial, industrial or institutional developments shall be the average daily flow determined multiplied by 4.0.

4. Infiltration

Sanitary sewer design capacity must include an allowance to carry unavoidable amounts of groundwater infiltration or seepage in addition to the peak sanitary flows. Collector and trunk sewers shall be designed to include an allowance of 100 gallons per day per inch diameter mile of pipe.

5. Design Capacities

Collector and trunk sewers shall be designed on the following basis:

a. Collector Sewers Twelve (12) Inches and Smaller

Peak design flow capacities shall be based on sewers flowing 2/3 full.

b. Trunk Sewers Fifteen (15) Inches and Larger

Peak design flow capacities for trunk or interceptor sewers shall be based on sewers flowing full, without head, using the design population density and appropriate land use determined by the City of Lawrence and the LU; and shall include an allowance for infiltration which will be reviewed on a case-by-case basis and is subject to the approval of the LU.

2.03 MINIMUM PIPE SIZES AND STANDARDS

A. Pipe Diameter

The required diameter of gravity sewers shall be determined by Manning's formula using a roughness coefficient, "n", of 0.013 or the pipe manufacturer's recommendation, whichever is greater. The minimum pipe diameter for public gravity sanitary sewers shall be eight (8) inches.

B. Minimum Slopes and Velocities

All sanitary collector and trunk sewers shall be designed and constructed to provide a minimum velocity when flowing full of two (2) feet per second. The slope of the sewer pipe shall be such that these minimum velocity requirements are attained. The minimum acceptable slopes for the design and construction of sanitary sewers are as follows:

THESE ARE MINIMUM SLOPES REQUIRED OF THE DESIGN. AS CONSTRUCTED SANITARY SEWERS FOUND TO HAVE LESS THAN THIS MINIMUM SLOPE SHALL NOT BE ACCEPTED.

Pipe Size * (Inches)	**Minimum Slope * (Feet per 100 feet, %)**
8	0.45**
10	0.28
12	0.22
15	0.15
18	0.12
21	0.10
24 and greater	0.08

*4" and 6" lines are allowed for building sewers only. For details see UPC (Uniform Plumbing Code), latest edition, Indiana Department of Fire Protection and Building Safety.

** exceeds Ten States Standards min. of 0.40%

C. Minimum Depth

For the protection of the sanitary sewer lines from damage caused by utilities installed after the sanitary sewer has been constructed, the minimum depth to crown of all gravity sanitary sewers shall be 6.5 feet, and the minimum depth to crown of all force main sanitary sewers shall be 4.0 feet.

D. Building Sewers

Building sewers shall conform to the latest edition of the Uniform Plumbing Code and to these Standards.

The building sewer shall connect to the public sewer at the mainline fitting. Connections to manholes shall only be allowed at upstream terminating manholes. Generally, inside drop connections to manholes are not permitted, however, they may be used with the approval of the LU.

Building sewers within the right-of-way or easement shall be a minimum of six (6) inches in diameter. Minimum grade shall be 1/8" per foot. Building sewers shall have a wye cleanout located within three (3) feet of the building's exterior wall and extended to grade.

Cleanouts installed under concrete or asphalt paving, shall be made accessible by yard boxes or extended flush with paving with approved materials and be adequately protected.

Building sewers installed for future connections shall be terminated at the right-of-way or easement and plugged to ensure 100 percent water tightness. A ½ inch metal locator rod or a metal or wood marker post shall be installed at the end of the plugged line to four (4) feet above the finished grade.

2.04 SEWER STRUCTURES

A. Manholes

1. General

Manholes shall be installed at the end of each line; at all changes in grade, size, materials or alignment; at all sewer intersections and at the following intervals:

Pipe Diameter (Inches)	**Maximum Interval Between Manholes (Feet)**
8 to 18	500
21 and larger	800

The minimum inside diameter of manholes shall be as stated in Section 5.

Flow channels shall be shaped and formed in each manhole to provide a smooth transition of flow from all inlets to the outlet. The bench wall shall be formed to the crown of the inlet and outlet pipes to from a "U" as shown in the standard details.

At changes in sewer alignment and/or sizes, the energy gradient elevation shall not increase. This shall be accomplished by keeping the crown elevation continuous where possible for changes in sewer sizes.

Manholes proposed to be installed in unpaved areas shall be designed and constructed such that the top of the casting is a minimum of three (3) inches above the finished grade to prevent ponding of water over the casting. Positive drainage away from the manhole shall be provided.

2. Outside Drop Connections

Outside drop pipe connections shall be provided for all sanitary sewers entering a manhole at an elevation greater than 24 inches above the invert of the manhole unless an inside drop connection has been approved by the LU.

In areas where future residential, commercial and/or industrial growth can occur, all new manholes 15 feet deep or deeper shall be equipped with up to two (2) precast outside drop connections of a size and at an elevation to be determined by the LU at the time of design to allow for future connections at these points. The drops shall extend from the base to within 10 feet of the final graded surface elevation.

NOTE: THIS SHOULD NOT BE CONSTRUED AS TO IMPLY THAT EVERY MANHOLE SHALL BE PROVIDED WITH 2 OUTSIDE DROP CONNECTIONS.

B. Lift Stations

A construction permit shall not be issued for a sanitary sewer lift station until an economic analysis identifies or proves to the satisfaction of the LU that the lift station exhibits a lower 50-year life cycle cost than a gravity sewer.

The analysis shall be per latest standard practice for least cost (life cycle) as developed by ASTM and evaluate labor costs, maintenance cost (including parts replacements), operations cost and rehabilitation costs. The analysis shall take into consideration both interest and inflation rates.

2.05 PROTECTION OF WATER SUPPLIES

There shall be no physical connections between a public or private water supply system and a sanitary sewer or appurtenances thereto which would permit the passage of any polluted water into the potable supply. Sanitary sewers shall be laid at least ten (10) feet horizontally from any existing or proposed water lines. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten (10) foot separation, the appropriate reviewing agency may allow deviation on a case-by-case basis if supported by data from the design engineer. 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 to 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.

Sanitary sewers crossing water mains shall be laid to provide a minimum vertical separation distance of 18 inches between the outside of 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 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 prevent damage to the water main. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

2.06 EXISTING UTILITY STRUCTURES AND FACILITIES

The plans shall show the location of overhead and underground utility lines and existing sewers according to the best information presented and available. Plans shall be submitted to the utilities and shall have indicated to the best of their records the locations of their facilities and the route of the proposed sewer.

2.07 UTILITY COORDINATION

It is the responsibility of the Owner or their authorized representative to coordinate with and get approval from the various utilities, including the City of Lawrence. Further, it is the responsibility of the Owner to get authorization to encroach upon any other utilities easement(s) and secure such recorded encroachment as a requirement for dedication of the sanitary sewer system.

2.08 SANITARY SEWERS CROSSING DRAINAGE WAYS

Sanitary sewers shall be constructed of ductile iron pipe or shall be encased in a minimum of 6" of concrete wherever the sanitary sewer crosses under a naturally occurring drainage way (i.e. creeks, rivers, streams, etc.). Whenever applicable, the sanitary sewer crossing the drainage way shall be pressure tested to assure 100% water tightness prior to backfilling.

INDIANA STATE BOARD OF HEALTH

BULLETIN S.E.13-1983

SOME WASTEWATER FLOWS*

Type of Establishment*	**Gallons per Person of Wastewater Per Day Unless Otherwise Noted**
1) Institutions other than hospitals	180-120
2) Schools (without gym and showers)	15
3) Schools (with gym and showers)	25
4) Organizational camps only	
a) with showers and hand washing facilities	20 +
b) with toilets, showers and hand washing facilities + Cooking or central food service included.	40 +
5) Campgrounds	
a) with individual sewer connections (per site)	100
b) with community building only (per site)	50
6) Mobile home parks (per mobile home park space)	200
7) Motels and hotels (per room)	100
8) Restaurants along an interstate or major highway; 24-hour operation (per seat)	70
9) Restaurants; 24 hour operation (per seat)	50
10) Restaurants; less than 24 hour operation (per seat)	35
11) Bars and cocktail lounges (per seat)	35
12) Bowling alleys (per alley)	100

Gallons per Person of Wastewater Per Type of Establishment*	**Day Unless Otherwise Noted**
13) Places of employment (does not include industrial waste, per employee, per shift)	15-35
14) Day workers at offices	15
15) Picnic parks and areas	5
16) Drive-in theatres (per ramp parking space)	7
17) Service stations (per vehicle served)	10
18) Swimming pool bathhouse (per person)	10
19) Private dwelling (per dwelling)	245
20) Apartments	
a) One bedroom (per apartment)	200
b) Two bedroom (per apartment)	300
21) Shopping center (where stores are not known) (per square foot building area)	0.45
22) Churches	
a) Without kitchen (per sanctuary seat)	3
b) With kitchen (per sanctuary seat)	5
c) Beauty salon	35
d) Day care center	20

* The flows listed indicate a reasonable approach for the type of establishment referred to. Additional considerations will be necessary in some cases. For uses not mentioned in this table, flow estimates should be submitted for preliminary design review and possible approval prior to proceeding with final plans.

SECTION 3

MATERIALS

3.01 INTRODUCTION

The following Section provides a description of materials acceptable for the construction of gravity sanitary sewers, force mains, manholes and their appurtenances within the City of Lawrence. Use of other materials not specified herein will be allowed only with the written approval and authorization of the LU.

3.02 GRAVITY SANITARY SEWERS

A. General

The LU currently allows the use of the following pipe materials meeting or exceeding the minimum requirements/specifications set forth herein for the construction of gravity sanitary sewers:

Polyvinyl Chloride Pipe (PVC)
Reinforced Concrete Pipe (RCP)
Ductile Iron Pipe (DIP)
High Density Polyethylene Pipe (HDPE)

Vitrified Clay Pipe (VCP) is NOT approved materials for the construction of sanitary sewers within the City of Lawrence.

In general, all gravity sanitary sewer pipes shall be the bell and spigot type with elastomeric seal joints and smooth interior walls meeting or exceeding all requirements set forth in the latest ASTM Standard referenced herein. For installations with depths greater than 15 feet SDR 26 pipe shall be used instead of SDR 35.

THE LU DOES NOT ALLOW THE USE OF SOLVENT CEMENT JOINTS FOR GRAVITY SANITARY SEWERS SIX (6) INCHES IN DIAMETER OR LARGER.

Each length of pipe shall be marked per the requirements of the respective ASTM Standard.

Upon request, the Contractor shall furnish the LU, at his own expense, with copies of all material tests required by applicable ASTM Standards.

B. Gravity Sanitary Sewer Materials

Each pipe material acceptable for gravity sanitary sewer construction is separated into its own subsection for ease of revision and/or updating as follows:

1. Polyvinyl Chloride Pipe
   a. Pipe: Polyvinyl chloride (PVC) gravity sanitary sewer pipe shall be the integral wall bell and spigot type with elastomeric seal joints and smooth inner walls meeting or exceeding all of the requirements set forth in ASTM D-3034 for pipe diameters 15-inches or less and meeting or exceeding all of the requirements set forth in ASTM F-679 for pipe diameters greater than 15-inches.

For diameters 15-inches or less, the pipe shall have a minimum cell classification of 12454-B or 12454-C and for diameters greater than 15-inches, the pipe shall have a minimum cell classification or 12454-C; with all pipe having a minimum tensile strength of 34.50 Mpa as defined in ASTM D-1784.

PVC sanitary sewer pipe shall have a minimum pipe stiffness of 46 psi for each diameter when measured at 5% vertical ring deflection and tested in accordance with ASTM D-2412.

NOTE: Polyvinyl Chloride (PVC) Ribbed Sewer Pipe meeting or exceeding all of the requirements set forth in ASTM F 949-86a or ASTM F 794 is acceptable. The minimum cell classification acceptable shall be 12454-B or 12454-C as defined in ASTM D-1784. PVC Ribbed Sewer Pipe shall have a minimum pipe stiffness of 50 psi when measured in accordance with ASTM D-2412.

b. Joints: Flexible gasketed joints shall be compression type so that when assembled, the gasket inside the bell will be compressed radially on the pipe spigot to form a watertight seal. The assembly of joints shall be in accordance with the pipe manufacturer's recommendations and ASTM D-3212. The gaskets sealing the joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacture of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gaskets shall conform to the requirements of ASTM F-477.

   All field-cutting of pipe shall be done in a neat, trim manner using a hand or power saw, and the cut end shall be beveled using a file or wheel to produce a smooth bevel of approximately 15° and be a minimum depth of 1/3 the pipe wall thickness. Field cut pipe will be permitted at manholes, at prefabricated tees and wyes, and at the connection of new sanitary sewer to existing sanitary sewer.

   NO SOLVENT CEMENT JOINTS WILL BE ALLOWED ON PIPE 8" OR LARGER (Section 5.02-A)

   NOTE: Only smooth exterior pipe shall be used at manhole connections.

c. Fittings: Only manufactured fittings made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM D-1784 shall be used.

   SADDLE CONNECTIONS WILL NOT BE ALLOWED FOR NEW CONSTRUCTION.

d. Design: The minimum wall thickness for PVC sewer pipe and lateral sewer pipe 15-inches or less in diameter shall conform to SDR-35 Type PSM as specified in ASTM D-3034. The minimum wall thickness for PVC sewer pipe greater than 15-inches in diameter shall conform to T-1 as specified in ASTM F-679.

e. Marking: The date of manufacture, class of pipe, specification designation, size of pipe, name or trademark of manufacturer, and identification of plant/location shall be legibly marked on the outside of each pipe section in accordance with the ASTM D-3034.

f. Certification: Upon request the Contractor shall furnish the LU with manufacturer's certification stating the pipe supplied meets or exceeds all requirements of the applicable ASTM Standards AND these Standards.

2. Reinforced Concrete Pipe
Reinforced Concrete Pipe (RCP) is permitted for the construction of gravity sanitary sewers of all sizes.

a. Material: All reinforced concrete pipes shall be Class III, IV or V in accordance with ASTM C-76, latest edition; wall thickness "B" or "C" per site conditions and be manufactured from Portland cement and aggregate as specified herein.

Reinforced Concrete Low-Head Pressure Pipe in accordance with ASTM C-361 shall be allowed for gravity sanitary sewer construction.

b. Portland Cement: Portland cement for manufacture of concrete pipe and fittings shall be Type I or Type III and shall conform to ASTM C-150. Upon request by the LU, the Contractor shall furnish manufacturer's certificate stating the type of cement used in the manufacture of the pipe furnished.

c. Aggregate: The aggregate for manufacture of concrete pipe and fittings shall conform to ASTM C-33 except that the requirement for gradation shall not apply. Upon request by the LU, the Contractor shall furnish manufacturer's certificate stating the type of aggregate used in the manufacture of the pipe furnished.

d. Steel Reinforcement: Steel reinforcement shall be in accordance with the requirements of the applicable table in ASTM C-76. Reinforcement shall extend full into bell or spigot ends for pipes 36" and larger and shall extend full into the bell of rubber gasketed pipes 12" and larges. Elliptical reinforcement shall not be permitted. Longitudinal reinforcements shall be continuous and all reinforcement shall have a minimum concrete cover of one (1) inch.

e. Lift Holes: Lift holes shall not be permitted.

f. Joints: Concrete pipe shall be furnished with joints using either concrete bell or spigot or zinc coated steel bell and spigot rings or rubber seal and rings (Anderson Seal or an approved equal). All types of joints shall have a groove on the spigot for a rubber "O" ring gasket. Pipe joints using concrete bell and spigot or zinc coated steel bell and spigot rings shall conform to ASTM C-361 except that the gaskets shall be as specified hereinafter. Pipe joints using rubber gaskets shall conform to ASTM C-443. The joint shall be sealed with a rubber gasket conforming to ASTM C-443 so that the joint will remain watertight under all conditions of service. The steel bell shall be welded to the longitudinal reinforcing and a steel skirt (minimum 5 ¾ inches in length and fabricated from 16 gauge metal) shall be continuously welded to the inside face of the steel spigot ring and to the longitudinal reinforcement.

Profile gasket type joints using a self-lubricated gasket (Forsheda Style 138 or approved equal) on the single offset spigot and formed bell are acceptable. Joints shall be sealed with a profile rubber gasket conforming to ASTM C-443 so that the joint will remain watertight under all conditions of service.

Only one style of joint system will be permitted between a manhole run of pipe.

g. Absorption Limit: Absorption of the reinforced concrete pipe shall not exceed 6% of the dry weight.

h. Marking: The date of manufacture, class of pipe and specification designation, size of pipe, name or trademark of the manufacturer, and identification of plant shall be legibly marked on the inside of each section of pipe per the ASTM requirement.

i. Specials: Specials shall conform to the specifications for straight pipe insofar as applicable. Special design or construction necessary for specials shall be subject to approval by the LU on a case-by-case basis.

j. Gaskets: The gaskets sealing the joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacturer of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of ASTM C-443.

k. Sanitary Sewer Lateral Connections: Connections to the RCP sewer shall be subject to LU approval. Where lateral connection must be made to the RCP sewer, a rubber connector with stainless steel clamp (KOR-N-SEAL) shall be used. The connector shall be the sole element relied on to assure a flexible watertight seal of the pipe.

   The rubber for the connector shall comply with ASTM C-923 and shall be resistant to ozone, weather elements, chemicals including

   The stainless steel elements of the connector shall be totally non-magnetic Series 305 stainless steel. The stainless steel clamp shall be capable of sustaining applied torque in excess of 80 inch-pounds. It shall be the responsibility of the Contractor to submit details of the proposed connection to the LU for approval. Connections not approved by the LU shall be subject to removal and replacement with an approved adaptor.

l. Certification: The Contractor shall upon request furnish to the LU manufacturers' certification stating that all pipes, materials and pipe appurtenances supplied meet or exceed the applicable requirements of the ASTM Standards AND these Standards.

m. Microbiologically Induced Corrosion(MIC): Pipe shall be protected from MIC by the application of CON(mic)SHIELD, or approved equal, to the interior pipe surfaces. Authorized manufacturer is ConShield Technologies, Inc. (1-877-543-2094), or approved equal.

3. Ductile Iron Pipe
   a. Material: Ductile iron pipe in diameters from eight (8) inches through 36 inches shall be centrifugally cast and shall conform to ANSI Specification A21.51 and AWWA C-151, latest revision. Ductile iron pipe shall be Class 50, 51, 52 or 54-wall thickness dependent upon the site conditions and provided in minimum laying lengths of 18 feet. The LU shall approve ductile iron pipe larger than 36 inches in diameter on a case-by-case basis.

   b. Fittings: Fittings shall be standardized for the type of pipe and joint specified and shall comply with ANSI A-21.10, AWWA C-110.

c. Joints: Mechanical joints, slip or flanged joints shall be provided.

Mechanical joints and accessories shall conform to AWWA Standard C-111, ANSI A-21.11. The bolts and nuts shall be corrosion resistant high strength alloy steel.

The O-ring gaskets sealing the slip joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacturer of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes, groundwater, acids and alkalis, animal and vegetable fats, oils and petroleum products from spills, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of AWWA C-111 (ANSI A-21111).

Flanged joints shall be manufactured with laying dimensions, facing and flange detailed in accordance with AWWA Standard C-115 (ANSI A-21.15) Class 125.

d. Weights and Marking: Weights of pipe fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fitting in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.

e. Certification: The Contractor shall upon request furnish the LU with certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications and these Standards for each.

4. High Density Polyethylene Pipe
   a. Pipe and Fittings: HDPE pipe shall be the wall bell and spigot type with elastomeric seal joints and smooth interior walls. Pipe and fittings shall be made from high molecular weight high-density polyethylene material meeting the requirements of ASTM D-3350 Cell Class PE 334433C. All material shall be virgin resin. Only manufactured wyes, tees, adaptors of the bell and spigot type shall be used.

   NO SADDLE CONNECTORS SHALL BE ALLOWED.

   b. Joints: Flexible gasketed joints shall be compression type so that when assembled, the gasket inside the machined groove on the pipe spigot will be compressed radially in the pipe bell to form a watertight seal. Joints shall meet the requirements of ASTM D-3212.

   c. Gaskets: The gaskets shall be made of a rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacture of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to all requirements of ASTM F-477.

   d. Nominal ring stiffness: ALL HDPE PIPE SHALL HAVE AMINIMUM PIPE STIFFNESS OF 46 PSI WHEN MEASURED IN COMPLETE ACCORDANCE WITH ASTM D-2412.

The Ring Stiffness Constant (RSC) classification value for the pipe between bell and spigot shall comply with the minimum value of 57 lb/ft.

e. Installation: The installation shall be in conformance with Specification for installation of flexible pipe as per all applicable ASTM requirements including F-412, D-2321, D-2412, D-3212, and D-3350.

f. Certification: Upon request the Contractor shall furnish a certificate of conformance to the required ASTM Standards, these Standards and other conformance certifications in the form of affidavits of conformance, test results and/or copies of test reports.

g. Markings: Each length of HDPE sanitary sewer shall be clearly marked with the Manufacturer's Name, Trade name or Trademark, Nominal pipe size, Pipe Stiffness, Production Code/Extrusion Code, Material Cell Class Designation and ASTM number.

3.03 SANITARY SEWER FORCE MAINS

A. General

The LU currently allows the use of the following pipe materials, meeting or exceeding the minimum requirements set forth herein, for the construction of sanitary sewer force mains:

Polyvinyl Chloride Pipe

Ductile Iron Pipe

Pre-stressed Concrete Steel Cylinder Pipe

Each pipe segment shall be clearly marked per the requirement of the respective ASTM, AWWA and/or ANSI Standard.

B. Anchorage

Force mains shall be anchored to resist thrusts that develop at bends, angles, tees, etc. in the force main pipe. The magnitude of the forces to be resisted shall be calculated and provided as part of the Engineer's design submittal. The required anchorage shall be attained by installing restrained pipe joints, concrete thrust blocks or anchor blocks based upon sound engineering practices. Anchorage design at force main fittings shall be based on pipeline pressures of at least 25% greater than the maximum pump design shut off head plus a water hammer allowance with an appropriate factor of safety.

C. Air/Vacuum Relief Valves

Sanitary sewer force mains shall be designed to avoid the need for air or vacuum release lines. If possible, force mains shall be designed without high points and with the top of the force main below the hydraulic grade line at the minimum-pumping rate so that the relief valves will not be needed. If high points in the force main cannot be eliminated, an APCO air release valve or approved equal shall be installed at each significant high point where air could become trapped. The air release valve shall be installed in a manhole structure in accordance with the requirements of section 5.04, and provisions shall be required for draining the structure. A high point shall be considered significant if it is two (2)

feet or more above the minimum hydraulic grade line, or, when pumping is intermittent, above the static head line.

D. Force Main Materials

Each pipe material acceptable for force main construction is described in the following individual subsections for ease of discussion and revisions:

1. Polyvinyl Chloride (PVC) Force Main
   a. Pipes: PVC force main pipe shall conform to ASTM Specification D-2241, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR PR). The material used shall conform to ASTM Specification D-1784, Polyvinyl Chloride compounds, Class 12454-B (PVC 1120). The minimum pressure class /SDR rating acceptable shall be Class 200/SDR 21.

      The pipe fittings shall be pressure rated in accordance with recommendations of the Plastic Pipe Institute. Pressure class and standard dimension ratios (SDR) shall be as follows:

      Class 200: SDR 21

      Class 250: SDR 17

      Class 315: SDR 13.5

      All plastic pipe and couplings shall bear identification markings in accordance with Sections 2.5.2 and 2.5.3 of AWWA C-900-75, which shall include the National Sanitation Foundation (NSF) seal of approval. In addition, the plain end of each pipe length shall have two (2) rings, one (1) inch apart, painted around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or coupling.

   b. Joints: Joints shall be bell end or coupling push-on type.

      The push-on joint and joint components shall meet the requirements for ASTM Specification D-3139, Joint for the Plastic Pressure Pipe, using Flexible Elastomeric Seals. The joint shall be designed so as to provide for the thermal expansion and contraction experienced with a total temperature change of 75° F in each joint of pipe. Details of the joint design and assembly shall be in accordance with joint manufacturer's standard practice.

      The lubricant shall have no deteriorating effects on the gasket or the pipe. The lubricant containers shall be labeled with manufacturer's name. Gaskets shall meet all applicable requirements of ANSI Standard A-21.11.

   c. Fittings: Fittings shall be of the same material and class as the pipe with joints and gaskets to properly fit the PVC pipe.

   d. Installation: The installation shall conform to the requirements of the manufacturer, the AWWA Standard and as indicated on the plans and specified herein.

   e. Marking and Certification: Marking and certification requirements – see Section 5.02 b.1.e and f.

2. Ductile Iron Force Main Pipe
   All provisions of Section 5.02 – B.3. For Ductile Iron Pipe Gravity Sanitary Sewer shall be the minimum criteria for materials, specifications and installations of Ductile Iron Force Main Pipe. Section 5.02 – B.3 is reiterated herein.

   a. Material: Ductile iron pipe in diameters from eight (8) inches through 36 inches shall be centrifugally cast and shall conform to ANSSI Specification A21.51 and AWWA C-151, latest revision. Ductile iron pipe shall be Class 50, 51, 52 or 54-wall thickness dependent upon the site conditions and provided in minimum laying lengths of 18 feet. The LU shall approve ductile iron pipe larger than 36 inches in diameter on a case-by-case basis.

   b. Fittings: Fittings shall be standardized for the type of pipe and joint specified and shall comply with ANSI A-21.10, AWWA C-110.

   c. Joints: Mechanical joints, slip or flanged joints shall be provided.

      Mechanical joints and accessories shall conform to AWWA Standard C-111, ANSI A-21.11. The bolts and nuts shall be corrosion resistant high strength alloy steel.

      The O-ring gaskets sealing the slip joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacturer of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater; and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of AWWA C-111 (ANSI A-21111).

      Flanged joints shall be manufactured with laying dimensions, facing and flange detailed in accordance with AWWA Standard C-115 (ANSI A-21.15) Class 125.

   d. Weights and Marking: Weights of pipe fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fitting in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.

   e. Certification: The Contractor shall upon request furnish the LU with certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications and these standards for each.

3. Pre-stressed Concrete Cylinder Pipe Force Main
   a. Pipes and Fittings: Pre-stressed concrete cylinder pipe (PCCP) are allowed with design pressures approved by the LU for Force Main Installations with the following specifications:

      All material dimensions shall be subject to tolerate limits of their respective ASTM or ANSI Specifications. The manufacturer shall furnish pipe and fittings in accordance with the terms and requirements of Section 4 of AWWA C-301 and ANSI, AWWA 208-83 and C-208.

      Concrete and mortar materials shall conform to ASTM C-150 (Portland Cement), ASTM C-618 (Pozzolan), ASTM C-33 (Aggregates), ASTM C-494 (Admixtures) and ASTM C-172, C-31 and C-39 (Concrete for Pipe Cores).

Pre-stressing wire shall conform to ASTM A-648 (wire for circumferential pre-stressing), ASTM A-370 (Wrap Test), ASTM A-370, Supplement IV (Tensile Test and Reduction Area Test) and ASTM E-558 (Torsion Test).

Steel sheet for pipe cylinders shall have minimum yield strength of 30,000 psi and shall meet the requirements of ASTM A-570 or ASTM A-569. Steel plate for pipe cylinders and fittings shall conform to ASTM A-283 (Grade C or D) or ASTM A-36.

Each length of pipe shall have plainly marked inside near the spigot end the design pressure and the date of casting. In addition, each pipe shall be sufficiently identified to show its proper location in the pipeline by reference to layout drawings or schedules. Beveled pipe shall be marked to show degree of bevel, the point of maximum pipe length at the spigot end and the field top.

b. Joints: PCCP force main shall have push-on joints with steel joint ring with minimum yield strength of 30,000 psi and minimum elongation of 15%.

Steel strip bell rings shall conform to ASTM A-570 or ASTM A-569 (except that the maximum carbon content shall be 0.25%)

Steel plate for bell rings or special shapes for spigot rings shall conform to ASTM A-283, ASTM A-576 (Grade 1012 or 1015), or ASTM A-36. Merchant quality bars conforming to ASTM A-575 (Grade M1012 or M1015) and ASTM A-663 may be used provided surface finish is satisfactory. Gaskets for the joints shall be continuous rings made of a composition of natural or synthetic polyisoprene rubber. The cross section of gaskets shall be circular with a diametrical tolerance of ± 0.016 inches. Surfaces of gaskets shall be smooth and free from pits, cracks and other imperfections. The rubber compound shall be dense, homogeneous and free from porosity, and shall contain no rubber substitute.

3.04 SANITARY SEWER MANHOLES

A. General

Sanitary sewer manholes shall be installed at the end of each line segment; at all changes in grade, size, materials and/or alignment; at all intersections; and at distances not greater than 500 feet for sewers 18 inches or less and 800 feet for sewers greater than 18 inches. Cleanouts shall not be substituted for manholes.

In unpaved/grassy areas manholes shall be designed and installed such that they extend a minimum of three (3) inches above finished grade to prevent water ponding. Positive drainage ways from the manhole shall be provided. .

All manholes shall be installed with an interior liner material designed to prevent infiltration and corrosion due to hydrogen sulfide. The lining shall be an epoxy based poly-urethane coating or equivalent. The lining shall be applied after the manhole has been installed and inspected for location and structural integrity. The lining shall protect all the concrete surfaces of the manhole and shall not obstruct flow of sewage through the manhole. The lining shall be completely cured prior to the testing of the sewer system constructed. The testing of the lining system shall be conducted by the installer of the system under the supervision of the LU inspector.

B. Types of Manhole Construction

The LU will accept/allow either Monolithic (Cast-in-Place) and/or Precast manholes conforming to the specifications herein.

C. Monolithic (Cast-in-Place) Manholes

Should a Contractor elect, and the LU approve, to build monolithic manholes, shop drawings showing at a minimum the concrete mix, steel reinforcement details, pipe connections and manhole dimensions shall be submitted to the LU for approval of each structure to be built. The shop drawings shall have been reviewed and certified by a registered Professional Engineer prior to submittal to the LU.

D. Precast Manholes

Precast reinforced concrete manholes including bases, risers/barrels, cones and flat slabs shall be constructed of either wet or dry cast Class A concrete meeting or exceeding the requirements of ASTM C-478, latest revision.

Precast reinforced concrete manholes shall be manufactured, tested and marked in accordance with ASTM C-478.

Precast manholes shall be constructed with the base and the first riser section as one complete precast unit.

Where used, precast manhole cones shall be the eccentric cone type.

NO "see through" lift holes shall be allowed on precast concrete manholes 48 inches in diameter or less. All lift holes shall be thoroughly wetted and completely filled with non-shrink mortar or epoxy grout; then smoothed and covered, both inside and out, with a trowelable grade butyl rubber base backplaster material to ensure water tightness.

All joints between precast manhole elements shall be made with an approved rubber gasket in accordance with ASTM C-443, latest edition, and a ½ inch diameter non-asphaltic mastic (Kent Seal or approved equal) conforming to AASHTO M-198 and Federal Specifications SS-521-A. The inside joints shall be mortared with hydraulic cement troweled to a smooth finish. The outside joints shall be sealed with mastic and wrapped with plastic wrap.

All manhole sections shall be steam or heat-and-water-mist cured and shall not be installed until at least five (5) days have passed after having been cast.

E. Manhole Bases, Inverts and Flow Channels/Bench Walls

Monolithic or Precast manhole bases shall be of 6" minimum thickness for 4' diameter and 8" minimum thickness for larger diameters, and shall be constructed of Class A concrete having a minimum compressive strength of 4,000 psi. The bottom invert of all pipe entering a manhole shall be at least three (3) inches above the top of the base slab so that the finished sewer channel may be installed and shaped. The installation of the final sewer channel may be done at the point of fabrication of the precast base or cast-in-place.

The flow channels within manholes shall be an integral part of the precast base. The channels shall be shaped and formed for a clean transition with proper hydraulics to allow the smooth conveyance of

flow through the manhole. The bench wall shall be formed to the crown of the inlet and outlet pipes to form a "U" shaped channel as shown in the standard details. The bench wall shall slope back from the crown at minimum ½ inch per foot to manhole wall.

For connections to existing manholes, flow channels shall be required and shaped as if it were a new manhole.

The standard details provide generalized standards for the construction/layout of flow channels for manholes with numerous connections.

F. Adjusting Rings

NO BRICK OR BLOCK SHALL BE USED IN THE CONSTRUCTION OF A MANHOLE OR TO ADJUST THE ELEVATION OF THE FRAME AND COVER.

Where one (1) solid riser or barrel section cannot be used, final adjustments in elevation of the frame and cover shall only be accomplished by the use of precast concrete adjusting rings per the standard details and shall conform to ASTM C-478. Riser rings other than that shown in the standard details may be accepted based upon written approval of the LU.

To adjust manhole castings located in driveways or on streets where slopes are encountered such that standard adjusting rings will not allow the casting to sit flush with the surface, the casting shall be adjusted to grade utilizing the "Infra-RISER"® multi-purpose rubber adjustment riser. An approved equal may be used with LU approval. Manufacturer's recommendations for installation shall be followed.

Rings shall be of a nominal thickness of not less than four (4) inches and not more than 12 inches total of adjusting rings shall be allowed for adjustment of the manhole frame and cover to required elevation.

A watertight seal shall be provided between the cone and riser ring, each adjoining riser ring, and riser ring and casting by the use of two (2) rows of ½ inch extrudable preformed gasket material. The extrudable gasket material shall be placed as shown in the standard details. As an alternative to adjusting rings, a cast-in-place section may be used.

G. Casting, Frame and Cover

The type of frame and cover to be used shall be Neenah R-1712-B-SP, Model 1022-1AGSMD as manufactured by East Jordan Iron Works, or equal with machined bearing surface and Type F concealed pick holes.

All castings shall conform to the requirements of ASTM and the dimensions as shown in the standard details, and the following:

1. Casting shall be of uniform quality, free from blow holes, porosity, hard spots, shrinkage, distortion or other defects. They shall be smooth and well cleaned by shot blasting or other approved method.

2. All castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner. Round frames and covers shall be of non-rocking design or shall have machined horizontal bearing surfaces to prevent rocking and rattling under traffic. All castings shall be fully interchangeable.

3. All weights shall not deviate from the tolerances permitted by ASTM Standards (i.e. ASTM A48-83 "Standard Specifications for Gary Iron Castings).

4. No open pick holes shall be allowed.

5. All castings shall be manufactured in accordance with ASTM A-48-83 Class 35B, and shall have a minimum tensile strength of 35,000 psi.

6. Sanitary sewer manhole covers shall have the words "sanitary sewer" cast in the cover in letter two (2) inches in height.

H. Extrudable Preformed Gasket Material

A nominal ½ inch size butyl rubber base gasket material, conforming to AASHTO M-198 and Federal Specification SS-S-210A, shall be used for adjusting ring grooves; between adjusting rings and cone; between adjusting ring and casting; and in joints of precast manhole sections. The gasket material shall be as manufactured by Hamilton Kent-Seal, RUB'R-NEK-L-T-M by K.T. Snyder or an approved equal. A compatible primer or solvent as recommended by manufacturer of butyl base material shall be used to prepare surfaces prior to application of butyl base material.

I. Trowelable Butyl Rubber Backplaster

Per the standard details, the exterior of the manhole from two (2) inches below the bottom riser ring on the cone section to and covering the base of the casting, including the voids on the outside joints of the riser rings shall be sealed with a trowelable grade butyl rubber base exterior backplaster material, ¼ inch minimum thickness when dry.

J. Special Types of Manholes

1. Outside Drop Connection

No inside drop manhole connections shall be allowed for new sewer construction. Inside drop connections to existing manholes shall only be allowed upon written approval of the LU.

Where a sanitary sewer or sanitary sewer lateral enters a manhole 24 inches or more above the invert of the outgoing sewer, the incoming sewer shall be connected to the manhole by means of an outside drop connection. All new sanitary sewers requiring a drop connection shall be constructed with an outside drop connection per the standard details. Outside drop connections may be either precast or monolithically poured.

Base for Manhole with outside Drop Connection – The footing for the portion of the manhole under the drop shall be monolithically poured at the same time as the rest of the manhole footing. A minimum of three (3)-½ inch diameter reinforcing rods shall be placed as dowels into the footing. These rods shall be tied to the reinforcements. The rods shall be tied to the reinforcement as specified in ACI Building Code Requirements. The rods shall be extended as the vertical part of the drop is constructed. In addition, the drop shall be tied into each joint of precast concrete manhole with a minimum ¼ inch rod to prevent any separation of the drop from the precast manhole.

Detailed drawing shall be submitted for approval for all field fabricated drop connections.

2. Special Flood Protected Manholes

   In areas susceptible to flooding, the top of the manhole shall be above the 100-year flood elevation. The Engineer shall identify the flood elevation on the plans and design the manhole to preclude the submergence of the manhole. No alternatives may be used without written approval of the LU.

3. Manholes Constructed on Existing Mains

   Where manholes are required to be constructed over existing lines the contractor shall be required to submit a detail of the proposed construction to the LU for approval prior to construction.

K. Manhole Diameters

The following are minimum manhole diameters for sanitary sewers entering/exiting a manhole at the following range of angles:

MANHOLE DIAMETERS		
Pipe Size	**Pipes Entering/Leaving at 0° - 45° Bend**	**Pipes Entering/Leaving at 45° - 90° Bend**
8" – 21"	48"	48"
24"	48"	60"
27" – 30"	60"	60"
33" – 36"	60"*	72"

*Note: 72" if the "A" lock connector is used

All manholes in excess of 20 feet in depth shall be 60" diameter.

L. Steps

All steps shall be ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, Polypropylene plastic, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm)

M. Sewer Pipe to Manhole Connections

To connect a sanitary sewer to a manhole, a flexible boot KOR-N-SEAL 1 or 2, flexible connector, cast-in-place Dura-Seal gasket, "A" lock gasket or an approved equal shall be used. Connections to an existing manhole shall be a flexible boot KOR-N-SEAL or approved equal.

If the flexible boot connection is used, it shall be placed in the reinforced concrete manhole base and secured to the pipe by a stainless steel clamp. Flexible connector shall conform to ASTM C-923.

The cast-in-place inflatable gasket shall conform to ASTM C-923.

All connections shall provide for a watertight seal between the pipe and manhole. The connector shall be the sole element relied upon to assure a flexible watertight seal of the pipe to the manhole.

The rubber for the connector shall comply with ASTM C-023 and shall be resistant to ozone, weather elements, chemicals, including acids and alkalis, animal and vegetable fats, oils and petroleum products.

The stainless steel elements of the connector shall be totally non-magnetic Series 305 stainless steel. The stainless steel clamp shall be capable of sustaining applied torque in excess of 80 inch-pounds. It shall be the responsibility of the Contractor to submit details of the proposed connection to the LU for approval. Connections not approved by the LU shall be subject to removal and replacement with an approved adapter.

N. Rejection of Precast Manhole Sections

Precast reinforced concrete manholes, risers and tops shall be subject to rejection for failure to conform to any of the following specification requirements:

1. Fractures or cracks passing through the shell, except for a single and crack that does not exceed the depth of the joint;

2. Defects that indicate imperfect proportioning, mixing and molding;

3. Surface defects indicating honeycombed or open texture;

4. Damaged ends, where such damage would prevent making a satisfactory joint;

5. Infiltration into manhole exceeding allowed limits;

6. The internal diameter of the manhole section shall not vary more than one (1) percent from the nominal diameter;

7. Not installed in conformance with Section 7.

8. Not clearly marked date of manufacturer, trade name, size designation part number, and ASTM number;

9. Having a deviation more than ¼" from the straight edge at any point across the top of manhole cone section or riser ring; and/or

10. Having any visible steel bars along inside or outside surface of the manhole except for reinforcement stirrups or spacers used to position the cage during manufacture.

11. Not **protected from microbiologically induced corrosion.**

3.05 BUILDING SEWERS

Building sewers shall be SDR 35, Schedule 80 or Schedule 40 PVC pipe conforming to ASTM D2241. See Sections 1.03 and 1.04 of this standard for more information on building sewers.

Vitrified Clay Pipe (VCP) shall NOT be permitted for building sewer construction.

SECTION 4

EXCAVATION, TRENCH SAFETY AND DUST CONTROL

4.01 GENERAL

This section provides for all surface removal, excavation and disposal of surplus material within the public right-of-way, trench safety system and dust control.

Trench safety is a key and vital issue and Owners should take the necessary steps to ensure that the Contractor they use to construct the sanitary sewer has included trench safety construction techniques and safety systems in the cost proposal. It is recommended that the cost proposals submitted to the Owner and the ultimate contract for the construction/installation of the sanitary sewer constitute at least two (2) pay items. The first pay item should provide for all work specified in this and all other Section with the exception of Trench Safety Systems. The second pay item should be for all work performed and materials furnished under Section 6.03 – "Trench Safety System" for all excavations five (5) feet in depth or greater per OSHA Part 1926 of the Code of Federal Regulations. Payment for this item can be per lump sum or per lineal foot of trench.

All trenches or excavations shall be backfilled to the original surface of the ground or such other grades as shown on the design plans or as directed. In general, the backfilling shall be carried along as speedily as possible and as soon as the concrete, mortar and/or other masonry work and pipe joints have sufficient strength to resist the imposed load without damage.

4.02 SURFACE REMOVAL (WITHIN PUBLIC RIGHT-OF-WAY)

For construction of the sanitary lines as indicated on the approved plans within the Public Right-of-Way, the Contractor shall remove the surface materials only to such widths as will permit a trench to be safely excavated, affording sufficient room for proper efficiency and proper construction. Where sidewalks, driveways, pavements, curb and/or gutter are encountered, care shall be taken to protect such against fracture or disturbance beyond reasonable working limits. All pavements shall be cut with an abrasive saw and concrete streets, driveways, walks, alleys, etc. cut to the nearest joint, and as required by the design plans and the LU.

Excavated topsoil shall be stored in a designated location as approved by the Engineer. The topsoil shall be protected in such a manner as to ensure the preservation of its quality. The Engineer shall inspect the topsoil before being backfilled in the work.

4.03 TRENCH SAFETY SYSTEM

The Contractor and the Owner are responsible for ensuring that safe working conditions exist and safety procedures are being followed at the work site.

The Contractor shall also be responsible for notifying the Indiana Occupational Safety and Health Administration (IOSHA), Indiana Department of Labor, when sanitary sewer construction jobs are to begin so that they may schedule their inspectors to be at the site to check on the safety.

The LU's observer is **NOT** responsible for policing the Contractor's safety program. If, in the opinion of the observer, an unsafe condition is noted, he will notify the Contractor of this condition and report it to the LU's Director of Operations. If the condition continues to exist the observer shall notify the LU's Director of Operations, document the unsafe condition in writing and/or through photographs, and leave the job site.

The LU's Director of Operations will contact IOSHA and request that they dispatch an inspector immediately. Further, the LU's Director of Operations or an authorized representative of the LU may inspect the site and may issue a Stop-Work-Order if, in his/her opinion, work is proceeding in an unsafe manner.

Regarding Trench Safety Systems, the Contractor shall design, install and maintain a "Trench Safety System" in strict compliance with OSHA Part 1926 of the Code of Federal Regulations and all other applicable federal, state and local regulations.

4.04 DUST CONTROL

The Contractor shall be responsible for maintaining the site and adjoining paved surfaces in a dust free condition per the requirements of the Indianapolis Air Pollution Control Division. Fugitive dust control is the sole responsibility of the Contractor.

SECTION 5

INSTALLATION

5.01 GENERAL

The following Section addresses the minimum requirements for the installation of sanitary sewers within the City of Lawrence.

5.02 WORKMANSHIP

A. Line and Grade

The Contractor and/or Engineer (Owner's representative) shall furnish and set all line and grade stakes (HUB) and stakes for bench marks. The benchmarks shall be set in strategic locations of the project in order to facilitate the Contractor's installation of the line and grade stakes (HUB) for each pipeline. Only the laser method shall be used to set the grade of the pipeline. LU must first approve any other method in writing. The Contractor shall constantly check line and grade of the laser beam and the pipe. Minimum grades shall be according to the 'Ten States Standards' or as directed by the LU on the approved plans.

B. Installation of Sanitary Sewers

Suitable tools and equipment shall be used for the safe and convenient handling and laying of pipe. Great care shall be taken to prevent pipe coating or wrappings from being damaged. Carefully examine all pipes for cracks and other defects. No pipe or fittings shall be laid which are known to be defective. If pipe or fittings are cracked, broken or defective after being laid, they shall be removed and replaced with sound material. Thoroughly clean all pipe and fittings before installation. All pipe and appurtenances should be kept clean until accepted as completed work.

C. Point of Commencement and Direction of Laying

The point of commencement for laying of sewer pipe shall be the lowest point in the proposed sewer line. Lay the pipe with the bell end of bell and spigot pipe or with the receiving groove end of tongue and groove pipe pointing upgrade. Any other procedure shall be followed only with permission of the LU.

Lay each pipe on an even firm bed as specified so that no uneven strain will come to any part of the pipe. Particular care shall be exercised to prevent the pipes from bearing on the sockets. Dig all bell holes for bell and spigot pipe.

Completely shove home all pipe (to the assembly mark). On pipe of the tongue and groove type 30 inches and larger in diameter, pressure must be applied to the center of each pipe as it is laid by a winch and cable or other mechanical means.

All connection fittings shall be sealed with a watertight stopper.

The Contractor shall extend the building wye lateral to the Right-of-Way and shall place a one (1) inch cast iron locator rod, or a metal or wood stake at the end of the pipe to four (4) feet above the ground surface. The purpose is to provide for ease of location of the wye stub.

D. Construction Bulkheads

Before extending a sanitary sewer, the Contractor shall provide a watertight bulkhead in the existing sewer immediately downstream of the point of connection. This bulkhead shall be left in place until the new sanitary sewer has been cleaned of all accumulated water and debris and accepted by the LU.

During all intermissions in construction of the sanitary sewer pipe, the open face of the last pipe laid shall be plugged, covered or bulk headed so as to prevent sand, water, earth or other materials from entering the pipe.

Whenever pipe and special castings are required to be cut, the cutting shall be done by skilled workmen in such manner as to leave a smooth end at right angles to the axis of the pipe without damage to the pipe casting or cement lining. CUTTING TORCHES SHALL NOT BE USED.

E. Laying of Pipe in Cold Weather

LU reserves the right to order pipe installation discontinued whenever, in our opinion, there is danger of the quality of work being impaired because of cold weather. The Contractor shall be responsible for heating the pipe and jointing material so as to prevent freezing of joints. Do not lay any pipe on frozen ground. No flexible or semi-rigid pipe shall be laid when the air temperature is less than 32°F unless the Contractor takes proper precautions per the manufacturer's recommendations and the Engineer AND the LU approves the method.

When pipes with rubber gaskets or resilient-type joints are to be laid in cold weather, sufficiently warm the gasket or joint material so as to facilitate making a proper joint.

F. Abandoned Sewers

Sewers and storm water drains, which are to be abandoned, shall be bulk headed with mortar and an eight (8) inch thick brick wall. Storm water drains, and sewer structures that are to be abandoned in place shall be filled with Cellular Concrete and plugged, unless other wise indicated on the Plans. Service shall be maintained in such sewers and drains until the LU shall order bulkheads placed. No timber bulkheads shall be allowed. All castings on such abandoned structures are the property of the LU and shall be salvaged by the Contractor and delivered as directed. Unless otherwise specified, all abandoned manholes, catch basins and inlets shall be removed to a depth of three (3) feet below the proposed or established grade or existing street grade, whichever is lower.

5.03 DEWATERING AND CONTROL OF SURFACE WATER

Where groundwater is encountered, the Contractor shall make every effort necessary to secure a dry trench bottom before laying pipe. The Contractor shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, well points, etc., necessary to depress and maintain the groundwater level below the base of the excavation. If the Contractor is unable to remove the standing water in the trench, the Contractor shall over-excavate the proposed bottom grade of the sewer bedding, and place not less than three (3) inches of Class No. 2 crushed stone (Indiana Department of Highway aggregate Classification) in the over-excavated area.

The Contractor and/or Owner shall be liable for all lawsuits, which may arise as a result of the Contractor's dewatering efforts.

The Contractor shall keep the site free of surface water at all times and shall install drainage ditches, dikes, pumps and perform other work necessary to divert or remove rainfall and other accumulation of surface water from excavations. The diversion and removal of surface and/or groundwater shall be performed in a manner, which will prevent the accumulation of water within the construction area.

UNDER NO CIRCUMSTANCES SHALL SURFACE WATER AND/OR GROUNDWATER BE DISCHARGED TO, DISPOSED OF OR ALLOWED TO FLOW INTO THE CITY'S SANITARY SEWER SYSTEM WITHOUT THE EXPRESSED WRITTEN APPROVAL OF LU.

5.04 TRENCHING

The width of the trench at and below the top of the sanitary sewer shall be only as wide as is necessary for proper installation and backfilling, and consistent with safety requirements. The minimum width of trench for sanitary sewers, including force mains, 42 inches in diameter and less shall be 1.25 times the outside diameter (O.D.) plus 12 inches.

Minimum Trench Width (inches) = 1.25 (O.D.) + 12

The minimum trench width for sanitary sewers larges than 42 inches in diameter shall be determined on a case-by-case basis by the Engineer and approved by the LU.

The design plans and specifications submitted to the LU for review, approval and issuance of a construction permit shall include a detailed trench drawing.

The design of the sewer pipe and structures is predicated upon the width of trench indicated above and, should these limits be exceeded, the Contractor shall be responsible for the provision and installation of such remedial measures as may be required by the Engineer and/or the LU.

Bell holes shall be excavated for bell and spigot pipe and mechanical joint pipe, so that the entire barrel of the pipe shall rest on the bedding.

The pipe trench shall not be excavated more than one hundred (100) feet in advance of pipe laying.

Whenever pipe trenches are excavated below the designed bedding bottom, the Contractor shall fill the over-excavation with mechanically compacted No. 8 (¼ inch to ¾ inch) crushed stone or No. 8 fractured face aggregate.

All rock, boulders and stone 6 inches in diameter or larger encountered in trenches shall be removed. Boulders or rocks are not to be used for trench backfill.

In cases where material is deposited along open trenches, the material shall be placed so that no damage will result to the work or adjacent property as a result of rain or other surface wash.

If the bottom of the trench is of undesirable material, an additional six (6) inches of trench bottom shall be excavated and filled with Class 2 crushed stone and compacted using a hand held mechanical tamper. Where the distance to stable ground is excessive, the Engineer shall order in writing other types of foundation, as he deems necessary subject to the approval of the LU.

Remove any rock(s) encountered within six (6) inches below the barrel surface of the pipe, replace with No. 8 crushed stone or No. 8 fractured face aggregate and compact.

5.05 BEDDING AND BACKFILL – SANITARY SEWERS

The following Section provides the minimum requirements for the bedding of pipe and the backfilling of the trench.

The standard details provide the bedding requirements for PVC, HDPE and PVC Composite; Ductile Iron and Concrete pipes.

Per Section 7.04 – Trenching, where the bottom of the trench is of undesirable material, an additional six (6) inches of trench bottom shall be excavated and a stable foundation shall be constructed using compacted No. 2 crushed stone.

All sanitary sewer pipes shall be laid to the lines and grade shown on the approved design plans unless otherwise approved by the LU.

A. Bedding – Sanitary Sewers

Bedding material shall be compacted No. 8 crushed stone or No. 8 fractured face aggregate and shall be placed in the trench bottom such that after the pipe has been placed thereon, imbedded to grade and aligned, there remains a 4 inch minimum depth or material below the pipe barrel and minimum of 3 inches below the bell.

The bell holes shall be excavated so that the entire pipe barrel rests on the bedding. The following presents the bedding requirements for each pipe classification:

1. Flexible Pipe: PVC and HDPE Pipe

   No. 8 crushed stone or No. 8 fractured face aggregate shall be placed around the sides of the pipe up to the side of the pipe to the spring line (½ the Outside Diameter). This material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped in to ensure compaction of the haunch area and complete filling of all voids. From the spring line to 12 inches above the crown of the pipe, bedding shall be added in six (6) lifts "walked" in for compaction. Backfilling of the remainder of the trench shall be as specified in the Section.

2. Semi-Rigid Pipe (Figure 7-2): PVC Composite and Ductile Iron Pipe

   No. 8 crushed stone or No. 8 fractured face aggregate shall be placed around the sides of the pipe up to the springline (½ the Outside Diameter). This material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped in to ensure compaction of the haunch area and complete filling of all voids.

   From the springline to six (6) inches or ½ the Outside Diameter above the top of the pipe, whichever is larger, bedding shall be added in six (6) inch lifts "walked" in for compaction.

   Backfilling of the remainder of the trench shall be as specified later in this Section.

3. Rigid Pipe (Figure 7-3): Concrete Pipe

No. 8 crushed stone or No. 8 fractured face aggregate shall be placed around the sides of the pipe up to the springline (½ the Outside Diameter). This material shall be shovel sliced or otherwise carefully place and "walked" in or hand tamped to ensure compaction of the haunch area and complete filling of all voids.

From the springline, the trench shall be backfilled as specified in this Section.

B. Backfilling Sanitary Sewers

1. Backfill Materials

The following materials shall be used to backfill the trenches in accordance with and in the manner indicated by the requirements specified herein:

Class I	Angular, six (6) to forty (40) millimeter (¼ to 1½ inch) graded stone such as crushed stone.
Class II	Coarse sands and gravels with maximum particle size forty (40) millimeter (1 ½ inch), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.
Class III	Fine sand and clay gravels, including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil types GM, GC, SM and SC are included in this class.
Class IV	Silt, salty clays and clays, including organic clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH and CL are included in this class. These materials are not recommended for bedding.

2. Backfill around Pipe (Bedding)

The Engineer and the Contractor shall agree upon Bedding and backfill materials prior to construction. Samples will be obtained and kept at the Engineer's office. The Engineer and the LU will permit no significant deviation from this material for use without authorization.

The term "Select Fill" shall mean the use of Class II or III backfill materials as described above.

The trench shall be backfilled per the following:

3. Areas Subject to Vehicular Traffic

In areas under proposed or existing paved roads or within five feet of pavement, sidewalks, curbs, gutters or similar structures, granular backfill material complying with the requirements of the Indiana Department of Highways Standard Specifications, Latest Edition shall be used.

The material shall be placed in uniform layers not exceeding six (6) inches, loose measurement. Within three (3) feet of the sanitary sewer pipe the backfill material shall be thoroughly and uniformly compacted with hand held mechanical tampers. The remaining backfill material shall be compacted with mechanical tampers. A minimum compaction of 95% Standard Proctor Density shall be achieved within the backfill material.

Jetting or flooding of the backfill or other alternative compaction methods and materials shall NOT be used without the approval of the LU.

4. Areas NOT Subject to Vehicular Traffic

In areas five (5) feet or more from the paved surfaces, the trench shall be carefully backfilled with clean fill material free of rocks larger than 6 inches in diameter, frozen lumps of soil, wood or other extraneous material.

5.06 TRENCH BOX PULLING AND SHEETING

When required by Occupational Safety and Health Act (OSHA) to protect life, property, or the work, sheet and brace all open cut trenches in accordance with CFR 1926. Upon completion of the work, all temporary forms, shores, and bracing shall be removed. All vacancies or voids left by the sheeting, while being withdrawn, shall be carefully filled with bedding material.

The Contractor shall employ adequate safeguards to prevent movement of the pipe joint. If any movement should occur, the Contractor shall reinstall the pipe.

The Contractor at his own expense shall repair any damage to pavement or other structures due to sheeting, shoring, or bracing.

Sheeting and bracing which is to remain in place shall be cut off at the elevation of 1.5 feet above the top of the sewer pipe.

5.07 SANITARY SEWER MANHOLE INSTALLATION

A. Preparation of Base

The bottom of the excavation/trench for the manhole shall be filled with a minimum of six (6) inches of No. 2 crushed stone mechanically compacted to form a stable base. Where poor or unstable soil conditions exist or over excavation has occurred, additional No. 2 crushed stone or Class B concrete shall be used to form a stable base.

B. Placement of Manhole Sections

Precast manhole sections shall be placed and aligned to provide vertical sides. The completed manhole shall be rigid, true to dimensions and watertight.

Per Section 5.04, the joints between manhole sections shall be made with an approved rubber o-ring in accordance with ASTM C-443 and a ½ inch diameter non-asphaltic mastic (Kent Seal or equal) conforming to AASHTO M-198 and Federal Specifications SS-521-A.

C. Pipe Connections to Manholes

Connections to new or existing manholes shall be per Section 5.04-M. Connections to existing manholes shall require the installation of flow channels and bench walls per Section 5.04-E.

Where the Contractor connects to an existing manhole, that manhole shall be rehabilitated to current standards of the LU. This requirement shall include rehabilitating flow channel, as well as prescribed measures to reduce the amount of infiltration and inflow to required levels.

D. Backfilling of Manholes

Manhole backfilling and compaction shall comply with the requirements as specified for the adjacent sanitary sewer.

E. Placement of Adjusting Rings

Per Section 5.04-F, seal all joints; 1.) between the casting and adjusting ring/chimney, 2.) between adjusting rings with one ½ inch diameter cord of extrudable preformed gasket material, and 3.) between the adjusting rings and precast cone section with a minimum of two ½ inch diameter cords of extrudable preformed gasket material. Between adjusting rings, the extrudable gasket material shall be placed in the keyways and be of sufficient quantity to completely fill the joint cavity.

F. Manhole Waterproofing

Per Section 5.04-I, the exterior of the manhole from two (2) inches below the bottom of the adjusting rings on the cone to and covering the base of the casting, including the adjusting rings, shall be coated and the voids shall be filled with a trowelable grade butyl rubber base backplaster material.

G. Connection for Future Sewers

All sewer structures shall be designed based on the future estimated growth (See Section 4). In areas where future residential or industrial growth can occur, manholes over 15 feet in depth shall be equipped with up to two (2) outside drop connections installed per Section 4. Future or unused connection pipes shall be bulk headed with a watertight stopper.

H. Outside Drop Manholes

See Section 5.04-J for details.

5.08 INSTALLATION OF BUILDING SEWERS (LATERALS)

A. A connection permit issued by LU shall be obtained prior to the installation of a building sewer.

B. Per Section 1.03, only PVC SDR 35, Schedule 80 or 40 wall bell and spigot type pipe shall be used.

C. Size and grade requirements shall be per the latest edition of the Uniform Plumbing Code.

D. All building sewers shall have a cleanout located within three (3) feet of the exterior building wall and shall be installed per the standard details.

E. Connections to the new sanitary sewers shall only be made at the manufactured fitting. No saddle connections shall be allowed if a manufactured fitting exists based upon approved as-built plans.

F. The point of commencement for laying of the building sewer pipe shall be at the connection to the main sewer and shall be laid with the bell end pointing upgrade.

G. Bedding per the specifications of PVC flexible pipe shall be required.

H. Connections to sanitary manholes shall not be made without the written approval of LU. Building sewers shall connect to the manhole, when approved, at an elevation of not more than 24 inches above the base of the manhole. No inside drop connections shall be allowed without written approval of LU.

5.09 MANHOLE REHABILITATION CEMENTITOUS LINER

A. General

The City of Lawrence Utilities specifies that approved manhole rehabilitation shall be accomplished by means of a sprayed on epoxy or polymer lining system. Product shall be SPECTRASHIELD by Spectra Tech, L.L.C., or approved equivalent. Contractors desiring to use products other than SPECTRASHIELD shall submit full specifications, guarantees, and usage history and product installation procedures to the LU for review and approval prior to any work commencing.

This section prescribes the minimum standards for the safe and efficient renewal of cylindrical or flat walled sewer structures such as manholes and wet wells, which are structurally stable, yet would benefit from sealing and reinforcing, to extend their useful life.

Cementitious liner systems may be used with the written approval of LU.

B. Cementitious Lining/Plugging/Patching Materials

1. Leak Plugging

   All visible leaks must be plugged prior to application of the cementitious or sprayed on liner system. Quick setting, non-shrink hydraulic cement mortars of the same or greater strength than the Liner Mix and/ or chemical grouts may be used. If water pressures are severe, the contractor may drill relief holes at the bottom of the manhole wall to concentrate the leaks before plugging.

2. Patching Mix

   Voids which have not compromised the structure in its overall soundness must be filled prior to lining with material of the same or greater strength that the Liner Mix.

3. Cementitious Liner Mix

   The liner, if approved for use, shall be made of densely compacted micro silica enhanced Portland cement mortar applied uniformly at a minimum thickness of 1 inch within 48 inch diameter manholes up to 14 feet deep, as conditions require. Liner Mixes properties shall attain physical properties as follows:

	24 Hours 28 Days (Minimum)	**(Average)**
Compressive ASTM C-109	3,000 psi	10,000 psi
Flexural ASTM C293	650 psi	800 psi
Elasticity ASTM C-469	180,000 psi	1,150,000 psi

Increase the thickness for depths greater than 14 feet, as shown in the Liner Thickness Design Guide. Liner mixes producing 3,000 psi or less compressive strength in the first 24 hours shall be applied at 1.5 times the prescribed minimum thickness.

The Liner material shall be delivered in factory prepared packaging suitable for mixing with just the addition of clean water, at the prescribed rate. No additives shall be used at the site without prior approval. Cementitious materials shall be PERMACAST MS-10,000 or approved equal, as approved by the Engineer prior to bidding.

C. Execution

1. Manhole Preparation (Cementitious Lining)

   Prior to the renewal process, a covering shall be placed over the base to collect debris and the interior shall be pressure washed at 3,500 psi or at a level sufficient to etch and thoroughly clean its surface. All leaks shall be plugged and all voids filled. All loose or defective material shall be removed. Care shall be taken to prevent solids from entering the sewer flows.

2. Mixing

   The Manufacturer's published technical specifications and directions for proportioning and mixing shall be strictly followed by the certified applicator.

3. Equipment

   Equipment shall be recommended by the manufacturer to ensure proper mixing and pumping of the mortar and shall be in good working order, according to the manufacturer's recommendations for safe operation. Only factory certified workers shall operate the equipment and perform the process. For best results a high-speed centrifugal spraying device with a controllable retrieval method shall be used to produce a uniform and dense application without the need to trowel, which can otherwise weaken the mortar by drawing water to its surface.

4. Application

   Once the interior surface of the manhole is prepared, the application shall commence according to the manufacturer's recommended procedures. In the presence of the owner's inspector, a single application, to the prescribed thickness (see Liner Design chart), shall be applied without delay or interruption to produce a uniform and monolithic liner at the prescribed minimum thickness. Multiple layers with time between applications for drying are not recommended.

   Once the lining process is completed, the manhole shall be covered to prevent air-drying and evaporation. In arid conditions or high temperatures, commercial curing compounds may be

applied. Particular care should be exercised when the mix water content is at the lower end of the prescribed range to prevent surface cracks.

D. Testing and Verification

The Owners inspector shall verify the thickness with a wet gauge. Any area found to be less that the minimum prescribed thickness shall immediately receive the additional material needed. Two test cubes shall be cast from each day's mix and tested for strength verification according to ASTM C 109 at the Engineer's direction.

The interior shall be visually inspected for thoroughness of coverage. When dry to the touch, the entire interior shall be tested with a holiday detector at the prescribed voltage to verify thickness and locate pinholes if any. Deficiencies shall be immediately corrected and retested.

Thickness Design Tables of PERMACAST Liner

Table 1. Traffic Load

Diameter (in)	Depth (ft)	Light Traffic			Heavy Traffic		
		12 hours	24 hours	7 days	12 hours	24 hours	7 days
		Thickness (in)	Thickness (in)	Thickness (in)	Thickness (in)	Thickness (in)	Thickness (in)
24"	1	1	1	0.75	1.75	1.25	1.25
	>2	0.5	0.5	0.5	0.5	0.5	0.5
36"	1	1.25	1.25	1	2	1.75	1.5
	>2	0.5	0.5	0.5	0.5	0.5	0.5
48"	1	1.5	1.5	1	2.25	1.75	1.75
	>2	0.5	0.5	0.5	0.5	0.5	0.5

Table 2. Hydrostatic Load

Depth (ft)	Light Traffic			Heavy Traffic					
	12 hours	24 hours	7 days	12 hours	24 hours	7 days	12 hours	24 hours	7 days
	Thickness (in)	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*	*Thickness (in)*
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.75	0.5	0.5	0.75	0.75	0.5
12	0.5	0.5	0.5	0.75	0.75	0.5	0.75	0.75	0.5
16	0.75	0.5	0.5	0.75	0.75	0.75	1	1	0.75
20	0.75	0.75	0.5	1	0.75	0.75	1	1	0.75
30	0.75	0.75	0.75	1	1	0.75	1.25	1	1
40	1	0.75	0.75	1	1	1	1.25	1.25	1

NOTE: Materials which develop strengths less than 3,000 psi in 24 hours can be applied at 1 1/2 times the thickness as shown above for equivalent strength / thickness valves.

E. Safety

If personnel are required to enter the confined space during the application procedure, each and all OSHA requirements, LU requirements, as well as those required by the manufacturer's material safety data sheets shall be complied with fully.

F. Measure of Payment

Payment shall be made at the unit price per vertical depth for each prescribed Liner thickness and coating thickness

G. Renewal & Corrosion Protection

At the Engineer's direction or when there is evidence of biogenic corrosion (MIC) from hydrogen sulfide gases, then the following steps shall be taken to renew the structure and to prevent bacterial corrosion.

1. Preparation and Procedure

   The liner shall be applied to the prepared interior, as specified in preceding sections, at the thickness necessary to restore the full cross-sectional thickness of the original wall.

2. Corrosion Protected Material

   The Liner shall be densely compacted micro silica enhanced Portland cement mortar with Con(mic)Shield, or approved equal, for MIC protection. It shall have the same strengths and it shall be applied in the same manner as specified in Section 2.03 Liner Mix.

   The material shall be delivered in factory prepared packaging suitable for mixing with just the addition of clean water and in the prescribed amounts. No other additives shall be used at the site, without prior approval. Materials shall be PERMACAST MS-10,000 with Con(mic)Shield or equal, as approved prior to bidding

3. Epoxy Lining for Chemical Corrosion Protection

   In cases of corrosion resulting from chemicals or at the Engineer's direction, a protective epoxy coating shall be applied over the fresh MS-10,000 to form a mortar/epoxy composite and to create a vapor barrier impervious to chemical corrosion.

4. Preparation & Procedure

   The Portland based Liner shall be applied to the prepared interior as specified in the preceding sections, at the thickness necessary to restore the full cross-sectional thickness of the original wall. The Liner shall have successfully demonstrated its compatibility to mechanically interface permanently with the coating.

5. Protective Coating

The protective coating shall be a 100% solids epoxy with no volatile organic compounds, light color to optimize visual inspection. Minimum physical properties shall be:

Hardness	ASTM D-2240	65 Shore D
Tensile Strength	ASTM D-638	10,000 psi
Compressive Strength	ASTM D-695	15,000 psi
Flexural Strength	ASTM D-790	13,000 psi
Adhesive Shear	ASTM C-882	11,000 psi

The epoxy shall be uniformly centrifugally cast onto the fresh mortar lining before re exposure to the chemicals can contaminate the underlying mortar. If application is delayed beyond 24 hours, the mortar liner shall be rinsed to neutralize its surface and the epoxy shall then be applied. The epoxy shall have a minimum thickness of .065 inches (65 mils) and shall not run or sag during placement. Performance standards shall be COR+GARD with MS-10,000, or equal as approved prior to bidding.

5.10 DESCRIPTION POLYMER/EPOXY BASED MANHOLE REHABILITATION

A. This section details the methods, procedures, materials and equipment as required to perform sewer manhole rehabilitation by use of sprayed on applications of polymer or epoxy based material. The completed system will provide a corrosion resistant liner to rehabilitate deteriorated manholes and prevent any further deterioration from hydrogen sulfide and other corrosive gases/acids within the wastewater stream.

5.11 SUBMITTALS

A. All materials and procedures required to establish compliance with the specifications shall be submitted to the Utility for review and approval. Submittals shall, at minimum, include the following:

1. Descriptive literature, bulletins, MSDS sheets and or catalogs of materials.
2. Work procedures including flow diversion plan, method of repair, etc.
3. Material and method for repair of leaks or cracks in manholes.
4. Final installation report on completed manholes.

5.12 10-YEAR LIMITED WARRANTY

CONTRACTOR shall guarantee, in writing, the manhole liner system against failure for a period of 10 years. Failure will be deemed to have occurred if the protective lining fails to (a) prevent internal damage or corrosion of the structure, (b) protect the substrate and environment from contamination by effluent, and/or (c) delaminates, chips, cracks or otherwise fails to adhere to the manhole wall, frame or otherwise maintain its integrity. If any such failure occurs within 10 years of initial completion of work by CONTRACTOR on a structure, CONTRACTOR will repair the damage and restore the lining at no cost to the Owner within 60 days

after written notification of the failure. Failure does not include damage resulting from mechanical, chemical abuse, or act of Nature. Mechanical or chemical abuse means exposing the lined surfaces of the structure to any mechanical force or chemical substance not customarily present or used in connection with structures of the type involved.

5.13 QUALITY ASSURANCE

A. The manufacturer and/or installer of the total liner system of manholes shall be a company that specializes in the design, manufacture or installation of corrosion protection systems for manholes. Installer shall be completely trained in leak repair, surface preparation and corrosion materials application on manholes. Corrosion materials/products shall be suitable for installation in a severe hydrogen sulfide environment without any deterioration to the liner.

B. To ensure total unit responsibility, all materials and installation thereof shall be furnished and coordinated with/by one supplier/installer who turnkeys the work and assumes full responsibility for the entire operation.

5.14 MATERIALS AND EQUIPMENT

A. The materials to be utilized in the lining of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment and shall come with a minimum of a one (1) year guarantee . Installer of corrosion protection products shall have long proven experience in the installation of the lining products utilized and shall have satisfactory installation record.

B. 3500 psi hydro blasting equipment shall be suited to remove corroded materials from the existing concrete/brick structure.

C. Equipment for installation of lining materials shall be high quality grade and be as recommended by the manufacturer.

D. The lining system to be utilized for manhole structures shall be a multi-component stress panel liner system as described below:

1. Liner

Installation	Liner
a. Moisture barrier	Modified Polymer
b. Surfacer	Polyurethane/Polymeric blend foam
c. Final corrosion barrier	Modified polymer

2. Modified polymer shall be sprayable, solvent free, two-component polymeric, moisture/ chemical barrier specifically developed for the corrosive wastewater environment.

3. Total thickness of multi-component stress panel liner shall be a minimum of 500 mils.

5.15 PRE-INSPECTION (to be performed prior to beginning actual relining)

A. Prior to conducting any work, contractor shall perform inspection of structure to determine need for protection against hazardous gases or oxygen-depleted atmosphere and the need for flow control or flow diversion.

B. Contractor shall submit plan for flow control or bypass to LU for approval prior to conducting the work.

5.16 SURFACE PREPARATION

A. Hydro blasting equipment shall remove all corrosion from structure. Final product shall be a cleaned, dry surface, free of any loose concrete or mortar and ready for liner application.

B. After completion of surface preparation and hydro blasting phase, CONTRACTOR shall perform a seven point check list, which is as follows:

1. Leaks
2. Cracks
3. Holes
4. Exposed Rebar
5. Ring and Cover condition
6. Invert Condition
7. Inlet and Outlet Pipe Condition

C. After CONTRACTOR identifies any and all defects in the structure, all leaks shall be repaired with a chemical or hydraulic sealant designed for use in field sealing of manholes against ground water infiltration. Severe cracks shall be repaired with a urethane based chemical sealant. Product to be utilized shall be as approved by LU prior to installation. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be made utilizing non-shrink grout or alternative method as approved by LU.

5.17 MATERIAL INSTALLATION

A. The limits of the corrosion protection system shall be all exposed concrete/brick surfaces including walls, tap sections, risers, etc., unless otherwise directed by LU.

B. Application of multi-component system shall be in strict accordance with manufacturer's recommendation. Final installation shall be a minimum of 500 mils. A permanent identification number and date of work performed shall be affixed to the structure in a readily visible location.

C. Provide final written report to LU detailing the location, date of report, and description of repair.

5.18 TESTING AND ACCEPTANCE

LU may randomly test structure lining for acceptance by wet gauge. Tested structures shall receive the minimum thickness as specified with an allowable variance of + or - 10% of the specified thickness. Multiple gauge readings in each randomly selected structure will be averaged. *(LU may require a vacuum test in accordance with ASTM C 1244-93 any or all of the structures receiving rehabilitation as acceptance criteria).*

Any structure, which fails testing, shall be repaired by methods approved LU at CONTRACTOR'S expense, and retested as required LU.

After all work is completed, CONTRACTOR shall provide LU with color photographs showing both the pre- and post-installation conditions.

Final corrosion protection system shall be completely free of pinholes or voids. Entire exposed concrete/brick surface shall be protected with corrosion protection system. Liner thickness shall be the minimum value as described elsewhere in this document.

5.19 REPAIR OF DEFECTS

A. All defects identified during inspection such as pinholes, low film mileage, etc. shall, at CONTRACTOR'S expense, be repaired with same material.

5.20 MEASUREMENT AND PAYMENT

Payment for structure rehabilitation via interior surface lining shall be made *per vertical foot per diameter* in accordance with the unit prices set out in the Contract Items of the CONTRACTOR'S Proposal for each structure receiving lining treatment and shall include the cost of all labor, equipment, materials, safety, surface preparation, patching, installation, testing and all incidentals necessary to provide a complete work in accordance with this Specification.

If project is being performed by DEVELOPER or DEVELOPER'S CONTRACTOR as a condition for project approval, all payment procedures or arrangements shall be between the DEVELOPER and CONTRACTOR.

If project is being performed by DEVELOPER or DEVELOPER'S CONTRACTOR as a condition for project approval, all payment procedures or arrangements shall be between the DEVELOPER and CONTRACTOR. Developer may also elect to have the LU arrange for CONTRACTOR to perform work and pay the LU directly based upon estimates provided by The LU, as obtained from CONTRACTOR. Any differences between actual and estimated costs will be refunded or billed by the LU as needed.

Additional technical product performance information is available upon request from the LU.

SECTION 6

SURFACE REPLACEMENT AND SITE RESTORATION

6.01 GENERAL

Section 8 pertains to the restoration of areas within the public right-of-way and/or acquired easements where an off-site sanitary sewer line is being constructed. Surface restoration within the site being developed is per the direction of the Owner, and permit requirements.

When the sanitary sewer construction is complete, remove all surplus material and rubbish from the site. That portion of the surface disturbed by construction shall be rebuilt to as good condition as it was before the commencement of the work. The project site shall be promptly and regularly maintained. Contractor shall be responsible for repairs of unsatisfactory trench backfilling or other unsatisfactory contracted services.

6.02 PAVEMENT, CURB AND GUTTER REPLACEMENTS

In all streets, alleys or other areas that are to be paved, all backfilling shall be well compacted by hand held or other mechanical compaction machines per the requirements of the City of Lawrence (LU). After the trench or excavation has been backfilled, the subgrade for the new paving, curb and/or curb and gutter shall be further compacted by rolling the backfill at subgrade elevation. After examination of the backfill and subgrade compaction by the Engineer and the LU the pavement, curb and/or curb and gutter shall be replaced.

All pavements, curbs and/or gutters shall be replaced with the same materials as that removed in accordance with the latest revisions of Standards of the City of Lawrence.

6.03 TRAFFIC CONTROL

The Contractor shall maintain vehicular and pedestrian traffic during all paving operation as required per the permit issued by the LU.

The Contractor shall provide flagmen, barricades and warning signs for the safe and expedient movement of traffic through construction zones within the right-of-way. This shall be in accordance with the principals and standards in the INDOT Standard Specification, latest revision.

6.04 LAWN AND GRASS AREA REPLACEMENT

All lawn and grass areas disturbed or damaged during construction shall be restored to original or better condition. Backfills, fills and embankments shall be brought to subgrade lever six (6) inches below finished grade. When subgrades have settled, deposit and spread topsoil to a finished depth of at least six (6) inches; fine raked, ready for seeding.

If the backfill, fill or embankment material is sand, an eight (8) inch layer of clay furnished by the Contractor at his expense shall be spread over the subgrade and thoroughly mixed into the sand subgrade. Mix the clay into the sand subgrade, then level and smooth. Deposit and spread topsoil to a finished depth of at least two (2) inches, and fine rake.

Commercial fertilizer 6-12-12 or equal shall be uniformly spread over the topsoil by a mechanical spreader and mixed into the soil for a depth of two (2) inches on areas to be seeded. This shall be done at least 48 hours

before the sowing of any seed at the rate of 35 pounds per thousand square feet. The area shall then be lightly raked or harrowed until the surface of the finished grade is smooth, loose and pulverized.

Then, the grass seed shall be sown by a mechanical seeder, and lightly raked into the surface or sown with a standard agricultural drill. The seeded areas shall be thoroughly watered with a fine spray in such a manner as not to wash out the seed. The Contractor shall use care in raking in order to avoid disturbance of the finished grade and seed distribution.

Seeding shall be done only within the seasons extending from August 15 to October 15, and from April 1 to June 1, unless otherwise permitted by the Engineer.

Contractor must submit a seed mixture certificate to the Engineer before using. Grass seed shall be sown at the rate of not less than three (3) pounds per thousand square feet and shall be the following analysis:

35 parts Kentucky Bluegrass
30 parts Perennial Rye
30 parts Kentucky 31 Fescue
5 parts inert matter

Hydro seeding shall be done in accordance with the INDOT Specifications, latest revision.

6.05 MULCHING

Adequate mulching material following seeding and fertilizing shall be applied, followed by cultipacking.

Mulch shall consist of:

1. Dry straw or hay of good quality and at the rate of 2 ½ tons per acre; or

2. Wood cellulose or can fiber mulch at a rate of 1,000 pounds per acre; or

3. A combination of good quality dry straw or hay free of seeds of competing plants at a rate of 2 ½ tons per acre and wood cellulose or cane fiber mulch at a rate of 500 pounds per acre; or

4. Manufactured mulch materials such as soil retention blankets, erosion control netting, or others that may be required on special areas of high water concentration or unstable soils. When these materials are used, follow the manufacturer's recommendation for installation.

   The seeded area shall be watered, maintained and patched as directed by the Engineer until the Contractor's work is completed and accepted.

6.06 STAND OF GRASS

The Contractor shall be required to establish a satisfactory stand of grass at least one (1) inch in height. Satisfactory stand of grass to be full coverage without bare spots. This is not required for areas subject to agricultural activities.

Within three (3) months after work completion, the Contractor shall be required to correct any defective work, such as bare spots in grass coverage, erosion, gullies, etc.

6.07 SODDING

The areas to be sodded shall be as shown on the plans and as specified in these Standards.

The use of sod shall be in accordance with the INDOT Specifications, latest revision. As a minimum, sod shall be fibrous, well rooted bluegrass, or other approved sod, with the grass cut to a height of not more than three (3) inches. Edges of sod shall be cleanly cut, either by hand or machine, to a uniform thickness of not less than 1 ½ inches, to a uniform width of not less than 16 inches, and in strips of not less than three (3) feet in length.

Sod shall be free from all primary noxious weeds as defined by the Indiana State Seed Law.

SECTION 7

INSPECTION, TESTING AND ACCEPTANCE

7.01 GENERAL

The following section describes the minimum requirements and general procedures for the inspection and testing of sanitary sewer systems to be dedicated to the City of Lawrence.

The sanitary sewer system shall not be accepted nor will connection permits be issued until all requirements for inspection and testing, including the filing of affidavits and any other paperwork are completed and all fees are paid in full.

Any section of sanitary sewer not passing the tests prescribed herein shall be repaired to the satisfaction and approval of the LU, retested and reinspected via closed circuit televising.

7.02 INSPECTION

Please refer to the General Information section of the specifications for main inspection.

Connection Permit – Building Sewer Inspection

As discussed in Section 1, a Sewer Connection Permit shall be obtained for any repair, modification or connection of a building sewer to a public sewer. Connection permits shall not be issued for connections to sanitary sewers not yet dedicated to and accepted by the LU.

Following the installation/repair/modification and prior to the backfilling of the Building Sewer, the Contractor/Plumber shall notify the LU that the Building Sewer is ready to be inspected. The LU shall then have 24 hours to make the inspection after which the Contractor/Plumber may backfill the trench. The notification of the LU shall adhere to the requirements of the City of Lawrence Ordinance 5-1-2-4.

If notification is not provided and the building sewer is backfilled prior to inspection, at the LU's request the Contractor/Plumber shall be required to re-excavate the trench so that an inspection can be made.

7.03 TESTING (GRAVITY SANITARY SEWERS)

Once constructed, all sanitary sewers and manholes shall be watertight and free from leakage. The rate of infiltration into the sanitary sewer system between any two adjacent manholes or the entire system shall not be in excess of 100 gallons per inch of pipe diameter per mile per day (100 gpd/in/mi.) The Contractor shall be required to repair all visible leaks to the satisfaction of the LU, even if the infiltration requirements are met.

The Contractor, at his expense, shall correct any leakage found during the infiltration test. The method of repair shall be per the approval of the LU; however, grouting of the joint or crack to repair the leakage shall not be permitted. If the defective portion of the sanitary sewer cannot be located, the Contractor shall remove and reconstruct as much of the work as is necessary to obtain a system that passes infiltration requirements.

All gravity sanitary sewers constructed of flexible pipe (PVC and HPDE) shall be mandrel tested no sooner than 30 days after installation per the requirements herein.

The Contractor shall bear the complete cost and supply all equipment necessary to perform the tests required.

All tests shall be conducted under the observation of the LU's Observer. It shall be the Contractor's responsibility to schedule testing with the Observer.

A. Low Pressure Air Test (Gravity Sewers)

All gravity sanitary sewers shall be tested for infiltration by means of a low-pressure air test as generally described herein. Any other infiltration test procedure will only be allowed following the submittal of the procedure to the LU for review and upon written approval by the LU

1. Equipment

The Contractor shall be responsible for providing all equipment and supplies necessary for the performance of a Low Pressure Air Test including but not limited to the following:

a. Mechanical or pneumatic plugs;

b. Air control panel;

c. Shut-off valve, pressure regulative valve, pressure relief valve and input pressure gauge. The pressure regulator or relief valve set shall be set no higher than 10 psig to avoid over pressurization; and

d. Continuous monitoring pressure gauge having a range of 0 to at least 10 psi. The gauge shall be no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of + 0.04 psi.

2. Ground Water Elevation and Air Pressure Adjustment

a. General

Per Section 5.04; a few key manholes shall have a ½ diameter threaded pipe nipple installed through the manhole wall directly on top of one of the sanitary sewers entering the manhole. Every manhole need not have a pipe nipple installed. The design Engineer shall designate the manholes to be used for gauging the ground water level. The pipe nipples shall be sealed with a threaded ½ inch cap.

Immediately before air testing, the ground water level shall be determined by removing the threaded cap(s) from the nipple(s) nearest the section to be tested, blowing air through the pipe nipple(s) to remove any obstructions, and then connecting clear plastic tube(s) to the pipe nipple(s). Each plastic tube shall be held vertically to allow groundwater to rise in it. After the water level in the tube has stopped rising, a measurement of the height in feet of water over the invert of the sewer pipe shall be taken. If the section to be tested is not immediately adjacent to an installed pipe nipple, the groundwater height shall be estimated based upon nearby height readings and the pipe's invert elevation.

Alternate ground water monitoring methods shall require the prior written approval of the LU.

b. Air Pressure Adjustment

The air pressure correction, which must be added to the 3.5 psig normal test starting pressure, shall be calculated by dividing the average vertical height, in feet of groundwater above the

invert of the sewer pipe to be tested, by 2.31. The result gives the air pressure correction in pounds per square inch to be added. (For example, if the average vertical height of groundwater above the pipe invert were 2.8 feet, the additional air pressure required would equal 2.8 divided by 2.31 or 1.2 psig. This would require a minimum starting pressure of 3.5 plus 1.2 or 4.7 psig.) The allowable pressure drop of 1.0 psig (or 0.5 psig) and the timing in Table 9.1A (or Table 9.1B) are not affected and shall remain the same.

c. Maximum Test Pressure

In no case should the starting test pressure exceed 9.0 psig. If the average vertical height of groundwater above the pipe invert is more than 12.7 fee, the section so submerged may be tested using 9.0 psig as the staring test pressure. The 9-psig limit is intended to further ensure workman safety and falls within the range of the pressure monitoring gauges normally used.

3. Test Procedure

Following are general procedures to be employed in the performance of the test. Figure 9.2 is a recommended Air Test Data Sheet for use in recording the test. Other test data sheets may be allowed based upon approval by the LU. These test data sheets shall be submitted to the LU.

a. Plug Installation and Testing

After a segment of pipe has been backfilled to final grade, prepared for testing, and the specified waiting period has elapsed, the plugs shall be securely placed in the line at the ends of each segment to be tested.

It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.

It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important in high groundwater situations.

When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probable point of leakage is at the junction of the manhole and the pipe. This fault may be covered by the pipe plug, and thus not revealed by the air test.

b. Line Pressurization

Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reached 4.0 psig greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 psig. If the groundwater is present, refer to Section 9.03 A.2. Ground Water Elevation and Air Pressure Adjustment to determine the internal pressure to be applied.

c. Pressure Stabilization

After a constant pressure of 4.0 psig (greater than the average groundwater pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2

minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.

d. Timing Pressure Loss

When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater back pressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average back pressure of any groundwater over the pipe). At a reading of 3.5 psig, or any convenient observed pressure reading between 3.5 psig and 4.0 psig (greater than the average groundwater back pressure), timing shall commence with a stopwatch or other timing device that is at least 99.8% accurate.

A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. Traditionally, a pressure drop of 1.0 psig has been specified. However, other pressure drop values may be specified, provided that the required holding times are adjusted accordingly. If the specified pressure drop is 0.5 psig rather than the more traditional 1.0 psig, then the required test times for a 1.0-psig-pressure drop must be halved. Specifying a 0.5 psig pressure drop is desirable in that it can reduce the time needed to accomplish the air test without sacrificing test integrity. Therefore, the following subsections contain provisions for both the traditional 1.0 psig pressure drop and the more efficient 0.5 psig pressure drop. All requirements for a specified 0.5 psig drop are given in parentheses. Test time criteria are presented later in subsection 9.03 A.4.

e. Determination of Line Acceptance

If the time shown in Table 9.1A (or Table 9.1B), for the designated pipe size and length elapses before the air pressure drops 1.0 psig (or 0.5 psig), the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued one the prescribed time has elapsed even though the 1.0 psig (or 0.5 psig) drop has not occurred.

f. Determination of Line Failure

If the pressure drops 1.0 psig (or 0.5 psig) before the appropriate time shown in Table 9.1A (or Table 9.1B) has elapsed, the air loss rate shall be considered excessive and the section of pipe shall be determined to have failed the test.

4. Test Times

a. Test Time Criteria

The Ramseier test time criteria requires that no test section shall be accepted if it loses more than "Q" cubic feet per minute per square foot of internal pipe surface area for any portion containing less than 625 square feet internal pipe surface area. The total leakage from any test section shall not exceed "Q" cubic feet per minute.

b. Allowable Air Loss Rate

A "Q" value of 0.0015 cubic feet per minute per square foot shall be utilized to assure the Owner of quality pipe materials, good workmanship, and tight joints.

c. Test Time Calculation

All test times shall be calculated using Ramseier's equation:

$T = (0.085) (D * K)/Q$

Where: T = Shortest time, in second, allowed for the air pressure to drop 1.0 psig,

K = 0.000419 DL, but not less than 1.0,

Q = 0.0015 cubic feet/minute/square feet of internal

surface area,

D = Nominal pipe diameter in inches, and

L = Length of pipe being tested in feet.

For more efficient testing of long test sections and/or sections of larger diameter pipes, a timed pressure drop of 0.5 psig may be used in lieu of the 1.0 psig timed pressure drop. If a 0.5 psig pressure drop is used, the appropriate required test times shall be exactly half as long as those obtained using Ramseier's equation for "T" cited above.

d. Testing Main Sewers with Building Sewers

In general, the LU will only approve the construction of the main line sewer and wye connections with the lateral stubbed-off to the property line. Building sewers will be allowed to be installed during the construction of the main line sewer only upon the written request to and written approval of the LU. This shall be clearly delineated on the design plans and specifications submitted for approval by the LU.

If building sewers are approved for construction by the LU as part of the mainline sewer they shall be included in the test and their lengths may generally be ignored for computing the required test times. This can be done because in practice, ignoring the branch, lateral, or house sewers will normally increase the severity of the air test whenever the tested surface area is less than 625 square feet so that the total rate of rejection may only be increased about 2%. If the total tested surface area is greater than 625 square feet, ignoring the lateral sewers will only slightly decrease the severity of the test.

e. Specified Time Tables

To facilitate the proper use of this recommended practice for air testing, the following tables are provided. Table 9.1A contains the specified minimum times required for a 1.0 psig drop from a starting pressure of at least 3.5 psig greater than the average back pressure of an groundwater above the pipe's invert. Table 9.1B contains specified minimum times required for a 0.5 psig pressure drop from starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Both tables also include easy to use formulas for calculating required test times for various pipe sizes and odd lengths. A series of examples are provided at the end of this Section that demonstrates the proper use of the tables.

5. Water Infiltration Test for Air Tests Failures

The Contractor may conduct a water infiltration test (weir test) when an air test fails to establish whether the 100-gal/in/mi/day maximum allowable infiltration rate is being exceeded. If the air test on the sewer system or any segment thereof fails, but the water infiltration test on the sewer system or segment thereof shall be deemed acceptable. However, the Contractor shall be responsible for repairing all visible leaks regardless of ability of the sewer system or segment thereof to pass any established test criteria enumerated in these Standards. The infiltration test shall not be considered a valid leakage test unless the top surface of the ground water level is at least 2 feet above the pipe during the test measurement. The Contractor may simulate this condition by flooding the trenches.

The rate of infiltration of water into the sewer, including appurtenances, shall not exceed 100 gallons per day, per inch diameter, per mile of sewer. The infiltration between any two adjacent manholes shall not be greater than 250% of the allowable infiltration rate. The infiltration allowance for manholes shall be computed using the total number of vertical feet of manholes expressed as the equivalent diameter sewer.

The maximum allowable infiltration, expressed in gallons per hour is shown below for various pipe and manholes sizes.

ALLOWABLE LIMITS OF INFILTRATION			
BASED ON 100/GAL./IN. DIA/MILE			
Diameter of Sewer (inches)	**Infiltration Per Foot Per Hour (gallons)**	**Diameter Of Sewer (inches)**	**Infiltration Per Foot Per Hour (gallons)**
4	0.0032	21	0.0166
6	0.0048	24	0.0189
8	0.0063	27	0.0213
10	0.0079	30	0,0237
12	0.0095	36	0.0284
15	0.0119	42	0.0332
18	0.0142	48	0.0379

48" diameter manhole = 0.0379 gal per vertical foot per hour.

B. Mandrel Test for Select Pipe

A 5% "GO-NO-GO" Mandrel Deflection Test shall be performed on all PVC, HDPE and PVC Composite gravity sanitary sewer pipe.

These pipes shall be tested with a rigid mandrel device sized to pass 5% or less deflection (or deformation) of the base inside diameter of the pipe. The mandrel test shall be conducted no earlier than 30 days after reaching final trench backfill grade, provided that in the opinion of the LU sufficient water densification or rainfall has occurred to thoroughly settle the soil throughout the entire trench depth. If densification, in the opinion of the LU, has not been achieved within the 30-day time frame, the mandrel size shall be increased to measure a deflection limit of 3%.

The mandrel (GO-NO-GO) device shall be cylindrical in shape and constructed with 9 or 10 evenly spaced arms or prongs. Mandrels with fewer arms shall not be allowed due to being insufficiently accurate. The mandrel diameter dimension "D" shall be equal to the inside diameter of the sanitary sewer. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall NOT be deducted from the "D" dimension but shall be counted as part of the 5% or lesser deflection allowance. As an example, the dimensions for the mandrel shown in Figure 9.3 for ASTM D-3034 PVC pipe shall be listed in Table 9.2. Each pipe material/type required to be Mandrel tested shall be tested with a mandrel approved by the pipe manufacturer and meeting the requirements of this Section. The "D" mandrel dimension shall carry a tolerance of + 0.01 inches.

The mandrel shall be hand pulled through all sewer lines and any section of sewer not passing the mandrel shall be uncovered, replaced or repaired to the LU's satisfaction and retested.

The contact length (L) shall be measured between points of contact on the mandrel arm. The length shall not be less than as shown in Table 9.2.

The LU shall provide proving rings to check the mandrel.

C. Manhole Testing

The LU's Observer shall visually inspect each manhole for leakage or evidence thereof after assembly and backfilling. If the manhole shows leakage or signs thereof, the manhole shall be repaired to the satisfaction of the LU and reinspected. The Contractor is required to perform testing on manholes in conformance to ASTM C1244-02 Negative Air Pressure (Vacuum) Test.

7.04 LIFT STATION AND FORCE MAIN TESTING

The following section describes the testing that shall be performed on the lift station pumps, piping and force main for acceptance and dedication to the LU.

NOTE: The Contractor shall be responsible for providing sufficient notice of all lift station and force main testing to the LU, 48 hours minimum, to ensure that the following personnel shall be present at the time of testing: (1) City Engineering representative, (2) Contractor's representative, (3) Developer's representative and (4) a representative from the LU.

A. Force Main Testing

1. General

Under the observation of the LU's observer, force mains shall be tested for leakage after installation and prior to final acceptance. The Contractor shall be responsible for providing all equipment and tools necessary to perform an air pressure test or hydrostatic pressure test conducted in accordance with AWWA Standards* for testing pressure pipe.

*These standards are material specific and generally reference manufacturer's guidelines. The standards apply to method of conducting air pressure tests only. Established pass/fail criteria are contained in the following sub-sections.

2. Air Pressure Testing

The LU, due to safety considerations in general, discourages air pressure testing of force mains. Air pressure testing of force mains shall only be conducted with the express written approval of the LU.

In instances where air pressure testing receives prior approval by the LU, the test method shall be in accordance with AWWA Standards and applicable portions of Section 9.03 of this Specification.

The force main shall be pressurized to 2.5 times the maximum operating pressure of the pump or to the pipe pressure rating, whichever is less. Under no circumstances shall the pressure in the line be permitted to exceed the rated pressure of the pipe.

The test pressure shall be maintained for a period of at least five (5) minutes with a maximum allowable air loss of 1% of the test pressure.

Any force main or section thereof failing the air pressure test shall be removed and replaced or repaired to the satisfaction of the LU and retested in accordance with this Specification.

3. Hydrostatic Pressure Testing

Hydrostatic pressure testing of force mains is the only method of force main testing that does not require prior written approval by the LU.

The Contractor shall be responsible for providing all of the equipment and tools necessary to conduct the hydrostatic test including, but not limited to, the following:

a. Hydrostatic test pump (jockey pump)

b. 4 1/2 " diameter calibrated pressure test gauge of range 0-150 psi graduated in 1 psi increments. The manufacturer's calibration papers and test date information shall be made available at the request of the LU.

c. All pipe plugs and/or caps required to perform the hydrostatic test.

d. Calibrated/graduated container to measure quantity of water required to be added during hydrostatic pressure test to maintain specified test pressure.

The hydrostatic pressure test shall be conducted in accordance with the applicable AWWA standard based on force main material and in accordance with ASTM E103 – "Standard Method for Hydrostatic Leak Testing". In conjunction with and in addition to the aforementioned standards, the hydrostatic pressure test shall proceed as follows:

a. The force main shall be completely backfilled prior to testing.

b. The influent line and effluent discharge shall be appropriately plugged/bulk headed. The plugs/bulkheads shall be equipped with a minimum of 2 openings for filling/draining the

pipeline and for bleeding air from the line. Thrust blocking restraints are required at each bulkhead and shall be furnished in accordance with the bulkhead manufacturer's requirements.

c. The test line shall be filled with water a slow rate to prevent air entrapment. In the case where concrete force main materials are being tested, the line shall be left at low pressure for 24 hours prior to pressure testing in order to minimize the apparent leakage due to water absorption by the pipe walls.

d. Trapped air shall be expelled through high point bleed off valves as the line is being filled.

e. The test line shall be pressurized to 1.5 times the pump shut-off head as determined form the pump manufacturer's performance curves or to 100 psi whichever is greater.

f. Water shall be added to the test segment to maintain the test pressure for a period of no less than 2 hours and no more than 8 hours. The LU's inspector must be present for at least the first 2 hours of testing.

g. The maximum allowable apparent leakage shall be 10 gallons per inch diameter per mile per day; however meeting these criteria shall not preclude the LU from requiring repair of any/all visible leakage identified during the test period.

h. If the force main or any portion thereof fails the hydrostatic pressure test, the Contractor shall remove and replace or otherwise repair the force main to the satisfaction of the LU, and the force main shall be retested.

Table 9.3 provides acceptable leakage rates in gallons per hour per 1000 feet of force main.

B. Wet Well Leakage Testing

Leakage tests shall be made and observed by the LU's Observer in the wet well. The test shall be the exfiltration test made as described below:

After the wet well has been assembled in place, all lifting holes shall be filled with an approved non-shrinking mortar. The test shall be made prior to placing any fill material. If the ground water table has been allowed to rise above the bottom of the wet well, it shall be lowered for the duration of the test. All pipes and other openings into the wet well shall be suitably plugged and the plugs braced to prevent a blow out.

The wet well shall then be filled with water to the top. If the excavation has not been backfilled, and observation indicates no visible leakage after 1 hour; the wet well may be considered to be satisfactorily watertight. If the test described above is unsatisfactory or if the wet well excavation has been backfilled, the test shall be continued. A period of time up to 24 hours may be permitted, if the Contractor so wishes, to allow for absorption. At the end of this period, the wet well shall be refilled to the top, if necessary; and the measuring time of at least 8 hours begun. At the end of the test period, the wet well shall be refilled to the top, measuring the volume of water added. This amount shall be extrapolated to a 24-hour rate and the leakage determined on the basis of depth. The leakage for each wet well shall not exceed 1 gallon per vertical foot for a 24-hour period. If the test fails this requirement, but the leakage does not exceed 2 gallons per vertical foot per day, repairs by approved methods may be made as directed by the LU to bring the leakage within the allowable rate of 1 gallon per foot per day. Leakage due to a defective section or joint or exceeding the 2-gallon per vertical foot per day maximum shall be cause for the rejection of the wet well. It shall be the

Contractor's responsibility to uncover the wet well as necessary and to disassemble, reconstruct, or replace it as directed by the LU. The wet well shall then be retested.

No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, etc.; i.e., it will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the LU's Observer that the water table is below the bottom of the wet well throughout the test.

C. Lift Station Pump Testing

The LU will perform lift station pump test during the lift station's final inspection. The Contractor shall be responsible for providing the clean water to run the pumps and perform the test(s).

1. Manufacturer's Start-Up

Prior to the LU's final inspection of the lift station equipment, the Contractor shall be responsible for coordinating start-up activities with the pump manufacturer's representative in accordance with the manufacturer's requirements. The LU's Observer must be present at the time of manufacturer's start-up.

The manufacturer's representative shall complete the appropriate one of the two-lift station check lists attached at the end of this Section. The LU's Observer shall witness the checklist in writing. The Contractor prior to final inspection shall remedy any deficiencies in equipment and/or workmanship noted during the manufacturer's start-up.

Upon successful completion of the manufacturer's start-up, the manufacturer shall deliver to the Contractor:

a. Three (3) copies of the completed, witnessed checklist with cover letter certifying that all pumping and electrical equipment has been installed and is operating in accordance with manufacturer's requirements;

b. Five (5) sets of Operation and Maintenance Manuals as specified in Section 10 of these Standards; and

c. One (1) complete set of Spare Parts as specified in Section 10 of these Standards.

2. Final Inspection

Contractor shall deliver two (2) copies of the manufacturer's start-up checklist at the time of final inspection. In addition, the Contractor shall provide the following pump test equipment and materials:

a. Water to conduct test

b. Amp/volt meter

c. Stop watch

d. Tape or level rod to measure float settings

e. Keel to mark float settings on lift station wall

f. Calibrated test gauge to measure operating head. The gauge shall be calibrated in feet of water from 0 to 100 feet in one foot increments

g. Manufacturer's pump performance curves.

The LU's representatives attending the final inspection shall review the manufacturer's checklist and re-check any deficiencies. The LU's representative shall then complete a cursory final inspection checklist and perform pump down tests that shall include the following:

a. Manual checks of all floats on/off operations, alarm and run lights.

b. Determination of inflow rate (if any),

c. Determination of pump capacity for each pump individually and both/all pumps simultaneously;

d. Determination of pump capacity with force main full. Verification of full force main shall be determined by pressure gauge provided by Contractor. Force main shall be considered full when the line pressure stabilizes; and

e. Plot performance of each pump or pump curves provided by Contractor.

Contractor shall provide all water necessary to conduct the pumping tests, and shall provide a connection for the test gauge on the blind-flanged tee in the valve vault. The stem connection shall be equipped with a plug valve to close the connection after testing is complete. The connection shall be left in place and shall be suitable for use as an air bleed off.

The pumping test results must meet or exceed the design pumping criteria approved by the LU to successfully pass the final inspection. Any deficiencies noted during the final inspection shall be repaired/replaced by the Contractor to the satisfaction of the LU and reinspected/retested prior to final acceptance.

7.05 CLOSED CIRCUIT TELEVISION INSPECTION

The Contractor shall be required to perform a closed circuit television inspection of the sanitary sewer between manholes as follows:

A. A camera equipped with remote control devices to adjust the light intensity and 1000 lineal feet of sewer cable shall be provided. The camera should be able to transmit a continuous image to the television monitor as it is being pulled through the pipe. The image shall be clear enough to enable the LU representative and others viewing the monitor to easily evaluate the interior condition of the pipe. The camera should have a digital display for lineal footage and project number and an audio voice-over shall be made during the inspection identifying any problems. The camera shall be capable of delivering clear color imagery and shall be equipped with pan-tilt-zoom capabilities.

B. The pipe shall be thoroughly cleaned before the camera is installed and televising is commenced.

C. A videotape and CD-ROM of the entire sewer line and reproduction map indicating the pipe segment numbers of all the pipe that has been televised shall be submitted to the LU for their records

If any pipe and/or joint are found to be leaking, the Contractor shall be required to repair that portion of the pipe to the satisfaction and approval of the LU.

TABLE 7.1A. SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

1 Pipe Diameter (in)	2 Minimum Time (min:sec)	3 Length For Minimum Time (ft)	4 Time For Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350ft	400 ft	450 ft
4	3:46	597	.830 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.148 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:40	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	25:30	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	28:20	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	31:10	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	34:00	76:55	102:34	128:12	153:50	179:29	205:07	230:46

TABLE 7.1B. SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

1 Pipe Diameter (in)	2 Minimum Time (min:sec)	3 Length For Minimum Time (ft)	4 Time For Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

TABLE 7.2

DIMENSION FOR 9 AND 10 ARM MANDREL (ASTM D-3034)

9 ARM MANDREL
D DIMENSIONS FOR

Nominal Diameter	**L**	**ASTM D3034 SDR 35 For Deflection of**	
		3% (in)	**5% (in)**
8	8	7.71	7.56
10	10	9.63	9.45
12	10	11.46	11.26
15	12	14.03	13.78

10 ARM MANDREL
D DIMENSIONS FOR

Nominal Diameter	**L**	**ASTM D3034 SDR 35 For Deflection of**	
		3% (in)	**5% (in)**
8	8	7.72	7.58
10	10	9.65	9.48
12	10	11.48	11.29
15	12	14.06	13.82

TABLE 7.3

PRESSURE TEST FOR FORCE MAIN
ALLOWABLE LEAKAGE PER 1000 FT PIPE IN GPH

FORMULA: $L = \frac{ND\sqrt{P}}{7400}$

L = Leakage GPH for 1000' Pipe

N = No. of Joints 12 ½' Lengths

D = Nominal Pipe Diameter

P = Average Pressure

Leakage in Gal/Hr for 1000' Pipe

Test Pressure	**Pipe Diameter**					
	2"	**3"**	**4"**	**5"**	**6"**	**8"**
75	.19	.28	.37	.47	.56	.75

EXAMPLE LOW PRESSURE AIR TESTS

A. GENERAL

The purpose of this Section is to illustrate the proper application of this recommended practice with regard to appropriate test time selection. The examples that follow include a variety of conditions that may be encountered in the field.

1. Example A

   A manhole-to-manhole reach of nominal 12-inch pipe is 350 feet long. No lateral connections exist in the reach. What is the required test time for a 0.5 psig pressure drop?

   Solution: The required test time can be read directly from Table 9.1B. For 350 feet of 12-inch pipe, the required test time is 9:58 (9 minutes and 58 seconds).

2. Example B

   A 350-foot section of nominal 12-inch pipe is ready for testing. A total of 128 feet of 4-inch lateral sewer pipe is connected to the 350-foot section and will be included in the test. What will be the required test time for a 0.5 psig pressure drop?

   Solution: Lateral sewers may be disregarded when selecting test times. Therefore, the required test time will be the same as for Example A, i.e. 9 minutes and 58 seconds.

   Note: If lateral sewers had not been disregarded, the required test time would be 10 minutes and 22 seconds, i.e. only 24 seconds longer.

3. Example C

   What should the required test time be for a 1.0 psig pressure drop in 327 feet of nominal 8-inch diameter pipe between two manholes?

   Solution: The exact test time is easily calculated by using Table 9.1A. Table 9.1A is used because a 1.0 psig pressure drop is specified. Since 327 feet exceeds the minimum test time for an 8 inch pipeline, the fourth column in Table 9.1A shall be used to quickly calculate the required test time as follows:

   $T = 1.520\ L = 1.52 \times 327 = 497$ seconds

   Therefore, the required test time for a 1.0 psig pressure drop is 497 seconds, or 8 minutes and 17 seconds.

4. Example D

   A manhole-to-manhole reach of nominal 24-inch pipe is 82 feet long. What is the required test time for a 0.5 psig pressure drop?

   Solution: Table 9.1B must be used because a 0.5 psig pressure drop is specified. Since 82 feet is less than the 99-foot length associated with the minimum test for a 24-inch pipeline, the minimum test time shall apply. Thus, the required test time for a 0.5 psig pressure drop must be 11:20 (11 minutes and 20 seconds).

5. Example E

A 412-foot section of nominal 15-inch sewer pipe has been readied for air testing. A total of 375 feet of nominal 6 inch lateral piping and 148 feet of nominal 4-inch lateral piping branch off of the 15-inch sewer line. All laterals have been capped and/or plugged and will be tested together with the 15 inch main line. The specified pressure drop that will be timed is 0.5 psig. What is the appropriate test time for this pipe network?

Solution: All lateral sewer sizes and lengths may be disregarded since their influence is generally not significant enough to warrant computation. Table 9.1B must be used for a 0.5 psig pressure drop. The fourth column in the Table provides the appropriate formula for calculating the required test time because 412 feet is longer than the third column value of 159 feet.

$T = 2.671\ L = 2.671 \times 412 = 1{,}100$ seconds

The required test time is 1,100 seconds or 18 minutes and 20 seconds.

FINAL INSPECTION
SUBMERSIBLE LIFT STATION CHECK LIST

JOB NO: _____

ADDRESS: _____

CONTRACTOR: _____

ENGINEER: _____

PUMP SUPPLIER: _____

KW METER NO: _____

DATE: _____

I. ELECTRIC

A. Is the power system 3 phase or 1 phase? 3 Phase ( ) 1 Phase ( )

B. If 3 phase, is grounded neutral provided? Yes ( ) No ( )

C. If above answer is "No", is transformer installed? Yes ( ) No ( )

D. Voltage Readings:

1. Between phases: L1, L2_____ L1, L3_____ L2, L3_____
2. High phase to ground: _____
3. Other legs to ground: _____
4. High Leg (L^3) is connected to motor only and not to any auxiliary circuits: Yes ( ) No( )

E. Do Latches on control panel work smoothly? Yes ( ) No ( )
Remarks?

_____
_____
_____

II. PUMP AND MOTOR CONTROLS

A. Breaker switches operate properly.
1. No. 1 pump Yes ( ) No ( )
2. No. 2 pump Yes ( ) No ( )
3. Control Circuit Yes ( ) No ( )
4. Remote Monitor Circuit Yes ( ) No ( )

B. Hand-off-automatic switches
1. No. 1 pump hand position operates Yes ( ) No ( )
2. No. 2 pump hand position operates Yes ( ) No ( )

C. Amperage
1. Name plate rating (amps) No. 1 motor _____
2. Amps pulled by No. 1 motor _____
3. Name plate rating (amps) No. 2 motor _____
4. Amps pulled by No. 2 motor _____

D. Automatic Operation

1. No. 1 pump Automatic Position operates	Yes ( )	No ( )
2. No. 2 pump Automatic Position operates	Yes ( )	No ( )
3. Do the floats sequence pumps properly with relation to lead pump on, lag pump on and alternation?	Yes ( )	No ( )

E. Seal Failure/Heat Sensor

1. Seal failure wires connected properly to seal failure circuit?	Yes ( )	No ( )
2. Test seal failure circuit ok	Yes ( )	No ( )
3. Heat sensor wires connected properly to heat sensor circuit?	Yes ( )	No ( )
4. Test heat sensor circuit ok	Yes ( )	No ( )

F. Control Components

1. Verify all electrical components are of U.S. manufacture and locally available	Yes ( )	No ( )

G. Alarm

1. High water alarm light and horn activate with test button?	Yes ( )	No ( )
2. Horn silence with silence button?	Yes ( )	No ( )
3. High water alarm light and horn activate with float?	Yes ( )	No ( )

H. Float Setting

1. Lead pump kicks on at EL _____ (____' ____") from wet well bottom.
2. Lead pump kicks off at EL _____ (____' ____") from wet well bottom
3. Lag pump kicks on at EL _____ (____' ____") from wet well bottom
4. Lag pump kick off at EL _____ (____' ____") from wet well bottom
5. Height of influent sewer above floor of wet well _____' _____".
6. Height of high water alarm above floor of wet well ____' ____".
7. Top of basin EL _____

Total basin depth _____' _____"

Remarks: _____

_____

_____

III. PUMPS AND MOTORS

A. Operation

1. Are pumps running quietly?

a. No. 1	Yes ( )	No ( )
b. No. 2	Yes ( )	No ( )

2. Are motors running quietly?

a. No. 1	Yes ( )	No ( )
b. No. 2	Yes ( )	No ( )

3. Is excessive vibration noticed?

a. No. 1	Yes ( )	No ( )
b. No. 2	Yes ( )	No ( )

Remarks: _____

_____

_____

IV. REMOTE MONITOR PANEL

A. Verify start-up procedure completed properly and put "On Line" with Sewer Maintenance division by remote monitor panel supplier — Yes ( ) No ( )

V. VALVES

A. Check Values
1. Do clappers swing freely? Yes ( ) No ( )
2. Does packing leak? Yes ( ) No ( )
3. Are counter weights adjusted properly? Yes ( ) No ( )

B. Plug Valves
1. Do valves open and close freely? Yes ( ) No ( )
2. Does packing leak? Yes ( ) No ( )
3. During operation, are all gates completely open? Yes ( ) No ( )

Remarks: _____

_____

_____

VI. PUMP DOWN TEST

A. Diameter, of wet well _____' _____".

(Re: 5'0" = 150 Gallon/Ft., 6'0" = 212 Gallon/Ft., 7'0" = 288 Gallon/Ft., 8'0" = 376 Gallon/Ft.)

ITEM	LEVEL	LEVEL DIFFERENCE	GAL.	TIME	TIME DIFFERENCE	GPM
Pump # On						
Pump # Off						
Pump # On						
Pump # Off						
Pump # On						
Pump # Off						
Pump # On						
Pump # Off						

Pump # _____ Average GPM _____
Pump # _____ Average GPM _____
Pump # _____ Average GPM _____
Pump # _____ Average GPM _____

VII. COVERT ALARM SYSTEM

A. Do latches on control panel work smoothly? Yes ( ) No ( )

B. Code Indication Functioning

1. Pump overload trip Yes ( ) No ( )
2. Crew on site key switch Yes ( ) No ( )
3. Wet well high water Yes ( ) No ( )
4. Dry pit high water or submersible seal failure Yes ( ) No ( )
5. Power failure Yes ( ) No ( )
6. Open Yes ( ) No ( )
7. Restore to normal Yes ( ) No ( )
8. Low Battery Yes ( ) No ( )

Remarks: _____

VIII. EQUIPMENT

	Manufacturer	Model	Size	Serial No.
Pumps				
Motors				
Pump Circuit Breaker				
Starters				
Heaters				
Control Circuit Breaker				
Remote Monitor				
Circuit Breaker				
Alternator				
HOA Switches				
Plug Valves				
Check Valves				

Other				

Remarks: _____

SECTION 8

LIFT STATIONS

8.01 GENERAL

This Section pertains to the requirements for the design and construction of submersible type lift stations, which are the primary type constructed as part of private development. Wet well/dry pit stations are acceptable, and their design and approval will be handled on a case-by-case basis.

Lift stations meeting or exceeding the requirements set herein will be approved. Any proposed alteration of the lift station dimensions, equipment, controls, etc., from the standards set forth herein will be approved only upon the submittal of plans and specifications of the proposed changes to the LU, and upon the LU's written approval.

Lift Stations, in general, shall be submersible type including a minimum of two (2) pumps and motors of minimum pumping capacity of 100 gpm under site operating conditions, wet basin, separate valve pit, valves, piping, hatches, guide rails, pump removal components, control center, float switches, remote monitor package, interconnecting electrical wiring, incoming power and telephone supply, and all other features regularly and normally required as a part of a complete and functional facility. All work shall be in accordance with site requirements, details in the Plans, these Standards and the manufacturer's recommendations. A 72" high chain link fence with a double-wide gate with a positive type-latching device suitable for locking with padlock shall enclose the lift station. The chain link fabric shall be 2-inch mesh woven from 9-gauge zinc alloy-coated core wire with a fuse-bonded PVC coating conforming to ASTM F668, Class 2B, 8-gauge finish.

All Lift Stations shall be designed for and operate on three (3) phase power with a maximum 200 Amp service. No deviation from this requirement shall be permitted without the express prior written approval of the LU.

8.02 GENERAL REQUIREMENTS

A. All of the mechanical and electrical equipment shall be an integral package supplied by the pump manufacturer with local representation so as to provide undivided responsibility. The package shall be equal in construction and performance to Hydromatic Pump equipment and other specific requirements set forth herein and in the approved plans.

B. The contractor shall submit to the LU for review and approval, three (3) sets of shop drawings, detailed specifications, pump warranty and performance characteristics for all of the equipment and fixtures to be furnished and installed. The shop drawings and equipment data shall be submitted with a cover letter or Contractor's stamp of approval, indicating that he has reviewed, checked and approved the data submitted. The LU will review the submittal and render a decision in writing as to the acceptability of the equipment. Without prior written LU approval, the item of work may not be accepted.

C. Any exceptions to this standard, or associated approved plans, shall be submitted in writing and clearly stated. The exceptions must be approved by the Engineer and the LU prior to proceeding with the work.

D. All components of the lift station that are exposed to weather shall be constructed of material that is resistant to corrosion and will not require surface protection throughout the expected life of the lift station. In general, these materials are stainless steel, aluminum, fiberglass reinforced polyester (FRP) and ultraviolet stabilized PVC.

8.03 OPERATING CONDITIONS

A. Each pump shall have a capacity of _____ gallons per minute at a total dynamic head of ____ feet when operating at _____ RPM. The pump motor shall be a minimum _____ horsepower, _____ RPM, _____ volt, 3 phase, 60 cycle. Each pump shall be provided with ____ feet of power cable and sensor cable.

8.04 PUMPING EQUIPMENT

A. Pumps shall be of the submersible type for handling raw unscreened sewage. Pump volute, motor and seal housing are to be high quality gray cast iron. Impeller shall be either cast iron or cast bronze of a non-clog design capable of handling minimum three (3) inch sphere solids, fibrous material, heavy sludge and other matter found in normal sewage applications. Impeller shall have pump out vanes on the back shroud of the impeller to keep pumped material away from the seal area and increase operating life. Impeller shall be either slip fit or taper fit with key to securely lock the impeller to the driving shaft. The pump volute shall be fit with a replaceable bronze wear ring to minimize wear on the impeller and help achieve longer balanced operating life. All fasteners shall be of stainless steel.

B. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Sealing shall be accomplished when metal-to-metal contact is made, resulting in controlled compression of the rubber O-rings without requirement of a specific torque limit.

C. The pump shall be provided with a mechanical rotating shaft seal system running in an oil reservoir having separate, constantly lubricated lapped seal faces. The lower seal unit between the pump and oil chamber shall consist of one (1) stationary seat and one (1) rotating ring held in place by its own spring. The lower seal shall be removable without disassembling the seal chamber. The upper seal between the motor and the seal chamber shall be of the same design with its own separate spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. The shaft sealing system shall be capable of operating submerged to pressures equivalent to two hundred (200) feet. No seal damage shall result from operating the pump unit out of its liquid environment. The seal system shall not rely upon the pumped media for lubrication. The seal chamber shall also be equipped with a seal failure sensor probe, which will sense water intrusion through the lower seal. This sensor is to be connected to an alarm in the control panel to indicate lower seal failure.

D. The stator winding, rotor and bearings are to be mounted in a sealed submersible type housing. Insulation utilized in the stator windings shall be class F with maximum temperature capability of 155 degrees Centigrade. Motor housing shall be filled with a high-dielectric oil to give superior heat transfer and allow the bearings to run in a clean, well lubricated environment. The pump and motor are to be specifically designed so that they may be operated partially or completely submerged in the liquid being pumped. The pump should not require cooling water jackets. Stators shall be securely held in place with a removable end ring and threaded

fasteners so that it may be easily removed in the field without use of heat or a press. Shaft shall be of stainless steel and supported by ball bearings. Motor shall be provided with heat sensing units attached to the motor windings, which shall be connected to the control panel to shut down the pump if overheating occurs.

E. Pump motor cable and heat sensor/seal failure sensor cable shall be suitable for submersible pump applications and this shall be indicated by a code or legend permanently embossed on the cable. Cable sizing shall conform to NEC specifications for pump motors and shall be of adequate size to allow motor voltage conversion without replacing the cable. Cable of the proper length shall be provided to eliminate the need for splices or junction boxes between pump and 'Control Center'. The cable shall enter the motor through a cord cap assembly, which is double-sealed allowing disassembly and disconnect of the wires at the motor and still not damage the sealed characteristics of the motor housing. Each individual conductor shall be color coded in accordance with generally accepted industry standards. The color coding shall designate the application of the conductor.

F. The pump mounting base shall include adjustable guide rail supports and a discharge connection with a one hundred twenty-five (125) pound standard flange. The base and the discharge piping shall be permanently mounted in place. The base plates shall be anchored in place utilizing epoxy type anchors with stainless steel studs and nuts as manufactured by HILTI Fasteners, Inc. or equal.

G. A rail system shall be provided for easy removal of the pump and motor assembly for inspection and service. The system shall not require a man to enter the wet well to remove the pump and motor assembly. Two (2) rails of two inch stainless steel pipe or one (1) rail of fiberglass reinforced plastic (FRP) I-Beam shall be provided for each pump. The guide rails shall be positioned and supported by the pump mounting base. The guide rails shall be aligned vertically and supported at the top by an attachment to the access hatch frame. One (1) intermediate guide rail support is required for each fifteen (15) feet of guide rail length for stainless steel pipe and one for each nine (9) feet of guide rail length for FRP I-Beam rail.

H. The pumps shall be equipped with sliding brackets or rail guides. To insure easy removal of the pumps, the rail guides attached to each pump shall not encircle the rails. A stainless steel lifting chain shall be provided for each pump.

I. The rails and rail guides shall function to allow the complete weightof the pumping unit to be lifted on dead center without binding and stressing the pump housing. The rail system shall function to automatically align the pumping unit to the discharge connection by a simple downward movement of the pump. No twisting or angle approach will be considered acceptable. The actual sealing of the discharge interface will be of the hydraulically sealing diaphragm type assembly with removable Buna-N diaphragm as supplied by Hydromatic Pump, or approved equal.

J. Pump warranty shall be provided by the pump manufacturer and shall warrant the units being supplied to the Owner against defects in workmanship and materials for a period of three (3) years under normal use, operation and service. The warranty shall be in printed form and apply to all similar units. A copy of the warranty statement shall be submitted with the approval drawings.

8.05 BASIN, VALVE PIT AND ACCESSORIES

A. The basin and valve pit are to be constructed of precast concrete, meeting the requirements of ASTM C-478. Cast-in-place monolithic structures may be substituted with prior written approval of the LU. Minimum valve vault and wet well diameter shall be 6'0". The actual arrangement of the structures is to be as shown in the approved plans. The wet well basin top shall be provided with a four (4) inch PVC vent having a downward pointing inlet and screen over the inlet opening.

B. The basin, valve pit, flat tops and base slabs are to be constructed of precast reinforced concrete manhole sections conforming to ASTM C-478. All joints between precast sections shall be made with an approved rubber O-ring in accordance with ASTM C-443 and a 1/2 inch diameter non-asphaltic mastic conforming to AASHTO M-198 and Federal Specification SS-521-A. In addition, the outside wall below grade is to be coated with bituminous waterproofing material. The top and bottom of the chambers shall be precast or may be poured in place concrete if approved by the Engineer and the LU.

C. The wet well pump basin and the valve pit chamber shall be enclosed at grade level with a reinforced concrete pad rectangular in shape and extending a minimum of 1'0" from the chambers outside dimension.

D. The lift station shall be provided with an access drive to the nearest public right-of-way conforming to the latest City of Lawrence Standards for Design of Driveways.

E. The pump supplier shall provide an aluminum two (2) door access hatch frame and door assembly to be installed in the concrete basin top. This door assembly shall provide access for removal of the pumps and shall support the guide rails. The doors shall be provided with lifting handle, safety latch to hold door in the open position and a hasp suitable for a padlock. The doors shall have a non-skid finish, designed for light, medium or heavy duty, depending on the location of the pumping station.

F. An aluminum single door access hatch frame and door assembly, similar to the one described above, shall be provided for use as entry to the valve pit. Minimum opening for the valve box entry shall be thirty-six (36) inches by thirty-six (36) inches.

G. A swing check valve with external swing arm and an eccentric plug valve shall be installed in the valve pit in each pump's discharge piping. A minimum clearance of twelve (12) inches shall be allowed from the bottom of the valves to invert of the pit. A drain pipe and check valve shall be installed to drain the valve pit back to the wet basin, but not allow the wet basin liquid to enter the valve pit. In addition to a tee or cross shall be provided in the valve pit for connection of item H below.

H. An additional eccentric plug valve shall be provided in the valve pit to allow access to the force main for bypass pumping. The bypass valve shall have an upward directed elbow and a male aluminum camlock fitting to allow attachment of City owned bypass pumping equipment. For 4" and smaller force mains, a 4" male ball and socket type connection shall be provided. For 6" and larger force mains, a 6" male ball and socket type connection shall be provided.

8.06 DISCONNECT SWITCH

A. A single main breaker disconnect switch of adequate size to provide power for the 'Control Center' and its related components shall be provided by the Contractor.

B. The disconnect switch shall be housed in a NEMA 4X stainless steel enclosure with an external operation handle capable of being locked in the ON position.

C. Fusible Disconnects are not permitted.

8.07 CONTROL CENTER

A. The control center shall be built in a NEMA 4X stainless steel enclosure and shall be suitable for the specified horsepower and voltage for the pumping equipment. The outer door of the panel shall be hinged dead front with provisions for locking with a padlock. Inside shall be a separate hinged panel to protect all electrical components.

B. A circuit breaker and NEMA rated magnetic starter with three (3) leg overload protection and manual reset shall be provided for each pump. The starters shall be model ESP100 as manufactured by Furnas, or approved equal. A separate circuit breaker shall be supplied for power to the control circuit. The control center shall include an extra circuit breaker of adequate size to provide 115 volt, single (1) phase power for remote monitor panel. The control center shall include a 2 KVA transformer to reduce supply voltage to 115 volt, single (1) phase to be used for all control functions. A green light and H-O-A switch shall be provided for each pump. A terminal strip shall be provided to make field connections of pump power leads, float switches, seal sensor leads, and remote monitor panel interconnections.

C. The control logic system shall be designed to operate two submersible pumps based upon wet well level, monitored by a liquid level control system model number 11928-5, as manufactured by Digital Control Corporation. The duplex pump control system shall automatically control two wastewater pumps. It shall perform two main control functions - duplex wastewater pump control and also provide high and low level alarms. With the addition of motor starters and circuit breakers, the 11928-5 shall work with any two types of level sensors, floats or external 4-20 mA sensor. The controller shall automatically detect and use the sensor type that is present and working. If a failure is detected in one sensor, the system shall automatically switch to other.

The system shall be designed to control two wastewater pumps using two 15 amp relays. The two pumps are operated in a lead/lag mode with the turn off points for each pump individually settable from the front panel. A pump alternator is built in which can be enabled or disabled from the front panel. The wet well level is measured by a pressure sensor. When the well level exceeds the lead channel 'ON' setpoint the first pump is turned on. Normally this will pump the well level down to the lead channel 'OFF' setpoint and the pump turns off. If the lead pump cannot handle the water flow, the level in the wet well will continue to rise until it reaches the lag channel 'ON' setpoint at which point the lag pump also comes on.

If the alternator switch is on, then a different pump will be assigned as lead pump each cycle. Each pump has an external disable input that can be connected to fail sensors in the pumps. If a pump is disabled the system shall automatically call another pump as the lead pump. A high level alarm and a low level alarm are built in with their setpoints settable from the front panel.

The system shall be able to read wet well level from a submersible transducer or activate pumps through backup float switches. The system shall be designed to function as a remote terminal in a SCADA system.

D. The control center shall incorporate connections for heat sensors, which are installed in the pumps. The connection shall disconnect the starter upon high temperature signal, and will automatically reconnect when condition has been corrected.

E. The control center shall incorporate connections for seal failure Sensors, which are installed in the pumps. The panel will have a seal failure alarm light for each pump. This alarm indicates failure of the lower mechanical seal in the pump. This will be an alarm light only and will not shut down the pump.

F. The control center shall include a resettable hour meter for each pump to register the elapsed operating time of each pump.

G. The control center shall have a high water alarm built-in the main enclosure. The high water alarm shall consist of a flashing alarm light with red Lexan plastic cover or red glass globe with metal guard mounted on top of the enclosure such that it is visible from all directions. An alarm horn shall be mounted on the side of the enclosure. A push to test horn and light button as well as a push to silence horn button shall be provided and mounted on the inside of the enclosure.

H. The control center shall include a condensate heater to protect against condensation inside the enclosure. The heater shall be placed so as not to damage any other component or wiring in the control center.

I. The control center shall include lightning protection.

J. The control shall include a phase monitor relay to provide an alarm contact for the remote monitor. The three phase sequence voltage relay shall of the eight pin connector type.

K. The control center shall include a GFI convenience outlet with a 20 AMP breaker and suitable transformer or power supply to provide 110 single (1) phase power to the convenience outlet.

L. The control center shall house the remote monitor SCADA system as described in item 'IX' below. All items described in that section shall be installed in the main enclosure and shall be wired and interconnected per the recommendations of the manufacturer.

M. PVC schedule 80 wall conduit shall be provided from the wet well basin to the control center which will allow the pump power cables, sensor cables, transducer cable and float switch cables to be pulled through without difficulty and allow the use of one (1) piece cables from the components to the control center. Each cable shall be sealed at the control center with a sealed type cord grip to avoid entrance of sewer gases into the control panel. Pump power cables shall be in one conduit, float switch and sensor cable shall be in one conduit and the transducer cable shall be in one conduit. The conduits shall terminate in a NEMA 4X raceway box below the main control enclosure, which allows the individual cables to be routed through the individual cord grips in the bottom of the main control enclosure.

JUNCTION BOXES SHALL NOT BE USED.

N. The control center and associated components shall be mounted on a non-maintenance type pedestal or mounting stand constructed of aluminum. The control center shall be located so as to provide safe access to the panel while wet well hatch doors are opened, and shall be positioned so as not to be between the access drive and the wet well.

O. Items such as circuit breakers, overload protection, relays, etc. shall be available and in stock by local sources.

P. In order to maintain unit responsibility and warranty on the pumping equipment and control center, the control center must be accepted in writing by the pump manufacturer, as suitable for operation with the pumping equipment.

8.08 LEVEL CONTROL

A. Float Controls

1. Sealed float type mercury switches shall be supplied to control backup pump operation, high level alarm signal and low-level alarm signal. Floats shall not be used as primary level controls. The mercury tube switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. The support wire shall have a heavy Neoprene jacket and a weight shall be attached to the cord above the float to hold the float in place in the sump. The floats shall also be capable of supporting themselves from a stainless steel support bracket.

B. Level Transducer

1. The liquid level of the wet well shall be sensed by a submersible level transducer Model 6100 as manufactured by Sigma, or approved equal. The transducer shall be a 2-wire type to operate from a supply voltage of 15 to 45 VDC and produce a 4-20 mA instrumentation signal in direct proportion to the measured level excursion over a factory-calibrated range, which will be indicated by readout on the front panel.

   It shall be of the head-pressure sensing type, suitable for continuous submerged, operation and shall be installed in accordance with the manufacturer's instructions. The bottom diaphragm face of the sensor will be installed where shown on the plans.

8.09 SYSTEM OPERATION

A. The submersible level transducer communicating with the controller shall activate primary level control. The float switches shall activate backup level control.

B. As sump level changes, the submersible level transducer shall continually transmit a signal to the pump controller, which shall be interpreted and field resettable to activate the pumps as follows. When sump level rises, a setpoint shall start the lead pump. With the lead pump operating, sump level shall lower to a lower setpoint and turn off the pump. The alternating relay in the control shall index on the stop setpoint of the pump so that the lag pump will start on the next operation. If sump level continues to rise when lead pump is operating, a specific setpoint shall energize and start the lag pump. Both lead and lag pumps shall operate together until the off setpoint turns off both pumps. If level continues to rise when both pumps are operating, the alarm level setpoint shall energize and signal the alarm. If one pump should fail for any reason, the second pump shall operate on the lag pump setpoint.

If the primary level control shall not activate the pumps or alarm, separate float switches shall provide activation of the backup level control system. One float switch shall be provided and set to activate at a level above the setpoints of the primary level control system. The float switch that is located above the primary level control setpoints shall activate the backup alarm and call for all pumps to start. The backup system shall continue to call for the pumps to run until the wet well level has lowered to the point that the backup low level float switch shall de-energized the call circuit. The backup low level float switch shall be set below the primary level control pump off setpoint. All level switches shall be adjustable for level setting from the surface.

8.10 REMOTE MONITOR PACKAGE

A. The station shall be equipped with a SCADA monitoring system as manufactured by Digital Control Corporation, or approved equal. The central component of the system shall be an RTU with float backup capability. The RTU shall be capable of communicating with the logic control unit. The system shall be a wireless telephone based system and shall utilize a wireless dial up telephone line.

B. The SCADA system shall include:

1. RTU with backup system
2. Modem with power supply (US Robotics compatible)
3. Telephone line surge protector
4. Uninterrupted power supply (UPS)
5. Panel door switch
6. Panic button

All components of the SCADA system shall be mounted and prewired in the main control panel enclosure.

C. The SCADA system shall be equipped with a rain gauge to measure daily rainfall at the lift station. The rain gauge shall be a tipping spoon style made of Styrosun plastic. The gauge shall self-empty to dump collected water. The gauge shall be capable of measuring rainfall in increments of .01" for accuracy and can record up to 7.2" per hour for heavy rains.

D. The Contractor shall install the monitor and coordinate testing with the LU to assure that the remote monitor reports the proper outputs prior to final acceptance of the lift station.

E. The Contractor shall provide a water main pressure transducer and monitoring equipment. Monitoring equipment shall be a 2-wire type to operate from a supply voltage of 15 to 45 VDC and produce a 4-20 mA instrumentation signal. Transducer shall be factory calibrated from 0-150 psi.

8.11 OPERATION AND MAINTENANCE MANUALS

A. Four (4) operation and maintenance manuals shall be submitted to the LU.

B. Manuals shall include, at a minimum:

1. Operation instructions;
2. Maintenance instructions;

3. Recommended spare parts list;
4. Lubrication schedules;
5. Structural diagrams;
6. As-built wiring diagrams; and
7. Bill of material.

8.12 SPARE PARTS

A. The Contractor shall supply one set of spare parts for each station, including at a minimum the following:

1. Impeller;
2. Upper seal assembly;
3. Lower seal assembly;
4. Upper bearing assembly;
5. Lower bearing assembly;
6. Wear rings; and
7. O-rings and gaskets (2 sets)
8. Single Phase Stations shall require one (1) complete pump set up

8.13 NOTES TO DESIGN ENGINEER

A. Sizing of Wet Basin

1. The wet well storage below the lowest inlet shall be a minimum of 5'0" and shall also meet the following criteria:

   a. Off float to be set at the pump manufacturer's recommended level but no less than 1'0" from the bottom of the wet well.

   b. The distance between the off float and the lead pump on float shall be set to provide storage capacity equal to:

      $$\frac{15 \times \text{RATED PUMP GPM}}{4}$$

      (i.e. 15 minute cycle minimum)

   c. The lag pump on float shall be set a minimum of 6" above the lead pump on float and a minimum of 6" below the lowest inlet invert

   d. The high water alarm float shall be set a minimum of 6" above the lag pump on float and a minimum of 6" below the lowest inlet invert.

   e. All float switches shall be set below the lowest inlet invert.

B. Station Warranty

Station warranty shall be 3 years from the date of acceptance per City of Lawrence Maintenance Bond Requirements.

C. Approval of Lift Stations by City of Lawrence

1. Final drawings and specifications of Lift Stations shall be submitted to the LU, 9201 Harrison Park Court, Lawrence, Indiana 46216, for approval 90 days prior to Lift Station purchase.

2. The Lift Stations meeting or exceeding this SPECIFICATION GUIDE will be approved. Any proposed alteration of the Lift Station dimensions, equipment, controls, etc. from the standards set in this SPECIFICATION GUIDE will be considered if such proposed alterations are accompanied with sufficient drawings, specifications and other data, and are presented to the LU for approval 90 days prior to alteration installation.

8.14 SMALL DIAMETER PRESSURE SEWERS

A. General

Small diameter pressure sewer systems incorporating the use of individual home grinder pump units will be allowed on a case-by-case basis subject to the written approval of the LU and the Indiana Department of Environmental Management. In general, these systems shall only be considered in areas where sanitary sewers currently serve the surrounding areas and the site cannot be served by a gravity sewer system.

The maintenance of the grinder pump station and building force main to the point of connection with the collector force main shall be the responsibility of the homeowner. The LU shall only be responsible for the maintenance of the collector force main.

SECTION 9

BUILDING SEWERS (LATERALS)

9.01 GENERAL

This Section of these Standards provides the general rules and policies set forth for the construction of building sewer services within the City of Lawrence. Many of the items discussed in this Section are set out verbatim in other sections of these Standards. It is the intent of this Section to provide those parties solely interested in the construction of building sewers with a concise statement of the policies governing the building sewer permit, construction and acceptance process.

9.02 BUILDING SEWERS

The following provisions and requirements pertain to building sewer policies contained in Title 5, Article 1, Chapter 2 of the City of Lawrence Municipal Code governing Sewers and Sewage Disposal within the City of Lawrence as amended. All provisions of the above mentioned Title, whether stated herein or not are made fully a part of these requirements.

A. Building Sewer Connection Permit

1. Connection Permits

   The City of Lawrence requires connection permits to be issued by the LU for all repairs, and/or modifications to or connection of a building sewer to a public sewer or another building within the City of Lawrence. Permits shall not be granted for connection to sanitary sewers not dedicated and accepted by the City of Lawrence.

2. Minimum Elevations for Gravity Connection

   A sanitary sewer connection permit shall not be granted to homes or buildings where the lowest elevation to have gravity sanitary services is less than one (1) foot above the top of the manhole casting elevation of either the first upstream or downstream manhole on the public sewer to which the connection is being made, unless a properly executed and recorded covenant is made by the homeowner. If the first upstream or downstream manhole is at a higher elevation due to the natural topography of the area, an alternate manhole will be selected for the purpose of determining this measurement and approved by the utility.

3. Grinder Pump Installations

   Generally, grinder pumps are discouraged and only permitted where topography and/or lack of gravity sewer availability requires their use. If a grinder pump is installed to service a property, the property owner is responsible for the installation to the point where the force main connects to the public gravity sewer. Since the homeowner is responsible to maintain and operate the grinder pump, no easements are required. In cases where the force main will be located in the right-of-way, the homeowner or their contractor shall be required to obtain a right-of-way use permit from the City of Lawrence Engineer's Office.

4. Permit Fee

   A fee of $150.00 per connection to the sewer shall be charged for a sanitary sewer connection permit, not including any required EDU fees, plan review fees and application fees. These fees shall cover the costs of the installation and inspection. Any re-inspection that may be necessary because of remedial construction will be charged an additional $50.00 reinspection fee.

5. Application for Connection Permit

   An application for a connection permit shall be made on the form prescribed by the LU and available at 9001 E. 59th Street, Suite 300, Lawrence, Indiana, 46216, or on the city's web site.

   An application shall require at a minimum the following information:

   a. Name and address of the owner;

   b. Name, address and telephone number of the Contractor;

   c. Address and legal description, if required of the premises for which the connection permit is being requested;

   d. Plans for the building sewer and connection, which at a minimum shall consist of the following:

      (1) Drawing(s) of the building;

      (2) Plat Plan including parcel boundaries;

      (3) Connection details including location of connection and routing of the building sewer;

      (4) Material of construction for the building sewer

      (5) Installation method; and

      (6) Elevation of lower floor and building drain specifically the elevation of the lowest gravity, sanitary service. All elevation shall be tied to USGS datum.

6. Who May Apply

   An application for a sewer connection permit shall only be made by the following:

   A plumbing Contractor licensed by the State and registered in accordance with Title 2, Article 1, Chapter 4 of the City of Lawrence Municipal Code.

   A Contractor who has met the surety bond and insurance requirement of the City of Lawrence. Surety bond requirements are met if the building sewer contractor has filed and maintains with the City a surety bond, as set forth in Title 2, Article 1, Chapter 4. Insurance requirements are met if the Contractor has secured and maintains a public liability and property damage policy as set forth in Title 2, Article 1, Chapter 4.

The LU may deny permits to any applicant who is currently in violation of this chapter or any other applicable regulations.

Application by persons other than those listed above may be accepted at the discretion of the Director of Operations.

All sewer work and other construction actually performed on or associated with the building sewer and its connection to the public sewer shall be in accordance with the rules and regulations of the Indiana Fire Prevention and Building Safety Commission and the Standards of the City of Lawrence.

7. Expiration of Permit

The connection permit shall expire if work is not initiated within 180 days from the date of issuance. Upon expiration, a new connection permit, including payment of the connection permit fee, shall be required.

The Director may for good cause extend the duration of the permit for a reasonable period. Requests for extension of the permit period shall be submitted in writing to the LU in advance of the expiration and shall state the reason for the request. Requests for extensions shall be forwarded to:

Lawrence Utilities
9201 Harrison Park Court
Lawrence, IN 46216

B. Prohibition against Clear Water Discharges

Except as provided in Item 2 below, it shall be unlawful to cause or allow the connection of a building sewer to a public sewer or other building sewer when such building sewer has any of the following sources of clear water connected to it:

Foundation/footing drains;
Sump pumps with foundation drains connected;
Roof drains;
Heat pump discharge;
Cooling water; and/or
Any other sources of clear/unpolluted water.

Any person found violating any provision listed above may be required to correct such connection at his expense.

In the event an industrial or commercial entity finds it necessary to discharge clear water consisting of cooling water and/or steam condensate into the public sewer; and the sewer has capacity to receive such clear water without affecting existing or future users, the LU may enter into an Agreement for such discharge that will define a metering system and any other requirements deemed necessary to measure the flow. The user rate for such discharges shall be calculated as provided in Title 5, Article 1, Chapter 4 of the City of Lawrence Municipal Code.

C. Dewatering Discharge to a Combined Sewer

It shall be unlawful to discharge the water resulting from dewatering activities to a combined sewer, whether such activity is temporary or permanent, without a valid sanitary sewer connection permit issued by the LU. As a condition to the issuance of a permit, applicant shall install, maintain and operate at the user's expense a metering device to measure the flow associated with such discharge.

DEWATERING DISCHARGE TO SANITARY SEWER SYSTEM IS STRICTLY FORBIDDEN.

Based upon the volumes determined by the measurements, user will be charged appropriate user fees.

User shall be required to submit monthly reports, subject to verification if authorized by the Director, to serve as the basis for billing, with any necessary adjustments in the amount made after verification.

D. Exemption for Certain Governmental Units

Connection permits shall be obtained for building sewer construction accomplished by or for a governmental unit, and inspections as specified shall be required. Fees shall be required as specified except for the following:

Building sewer construction for which a fee cannot be charged by the municipality because of federal or state law, or Building sewer construction accomplished by an employee or Contractor on behalf of the City.

E. Stop Work Order

The permit holder shall be responsible for all safety regulations and all obligations under Chapter XVII of Title 29, Code of Federal Regulations, Part 1926 otherwise know as Safety and Health Regulations for Construction. The LU is empowered to issue an order requiring suspension of work ("Stop-Work Order") whenever it determines that:

Construction is proceeding in an unsafe manner; or

Construction is occurring in violation of the LU's Standards and requirements and in such a manner that if construction is allowed to proceed, there is a probability that it will be substantially difficult to correct the violation; or

Sewer construction for which a connection permit is required is proceeding without a connection permit being in force. In such an instance the stop-work order shall indicate that the effect of the order terminates when the required permit is obtained. The stop-work order shall be in writing and shall state to what construction it is applicable and the reason for its issuance. One (1) copy of the stop-work order shall be posted on the property in a conspicuous place and one (1) copy shall be delivered to the permit applicant, to the person doing the construction and to the owner of the property or his agent. The stop-work order shall state the conditions under which construction may be resumed.

F. Mandatory Inspection of Building Connections

Notification – It shall be the duty of the holder of a connection permit to notify the LU in the manner described on the sanitary sewer connection permit that the sewer work is available for inspection. The

LU will conduct inspections on building sewer connections from 7:30-4:30 local time, Monday through Friday, except for observed City holidays. The building sewer, in its entirety from the foundation to the connection with the public sewer or existing lateral, must be exposed for inspection and be properly bedded in accordance with the LU's Standards to ½ the diameter of the building sewer. The responsibility for safety measures rests solely with the permit holder; all excavations shall adequately guard the public by barricades, fences, lights, and other such means as necessary. The permit holder may backfill the building sewer trench if the LU has not made an inspection within a 48-hour period after notice has been given to the LU. An inspection may be waived with or without conditions with the approval of the Director.

Right of Entry – The LU or its authorized agent shall have the right of entry to, upon or through any premises for purposes of inspection of sewer work and any other construction activity performed on or associated with the connection of the building sewer to the City sewer including inspection for clear water discharges into the sewer.

G. Building Sewer Construction

See General Information section of specifications.

H. Building Sewer Maximum Length

Except for building sewers serving single or double family residences, or single owner industrial facilities, connection permits will not be issued for building sewers exceeding 600 feet in length as measured from the outside of the building to the center of the public sewer unless the sewer is constructed in a dedicated easement or right-of-way in accordance with these standards. No more than 100 feet of a building sewer shall exist within a public right-of-way.

I. Maximum Number of Building Connections

No more than one (1) building will be permitted to connect to a building sewer unless approved by the utility management in writing prior to construction. Sewers with more than one (1) connection must be constructed as a public sewer in a dedicated easement in accordance with these standards, unless the LU determines that an exception is justified.

J. Building Sewer Responsibility

It shall be the responsibility of the property owner(s) whose property is benefited to provide for, install and make private connections for the use of their premises to an existing public or building sewer. Further, it shall be the responsibility of the owner to make all necessary repairs, extension, relocations, changes or replacements thereof and of any accessories thereto. These requirements may be altered, modified or waived at the discretion of the Director when it is shown that compliance is not possible due to extenuating circumstances.

K. Existing Foundation Drains, Roof Drains, Defective Building Sewers and Pumps

In the event the LU determines that a violation of Section 9.02B exists, the LU shall notify the violator, by certified mail that such violation exists. The notice shall describe the nature of the violation and the correction action(s) that must be taken. Such corrective action shall be taken within 30 days of receipt of such notice.

L. Protection of Water Supplies

There shall be no physical connection between a building sewer and the water supply system, or appurtenances thereto which would permit the passage of any polluted water into the potable supply. Building sewers shall be laid at least 10 feet horizontally from any existing or proposed water line. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot separation, the appropriate reviewing agency may allow deviation on a case-by-case basis. Such deviation may allow installation of the sewer closer to a water line, provided that the water line is in a separate trench or on an undisturbed earth shelf located to one side of the sewer, and at an elevation so the bottom of the water line is at least 18 inches above the top of the sewer.

Building sewer crossing water mains shall be laid to provide a minimum vertical separation distance of 18 inches between the outside of 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 crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water line joints. Where a water lines crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water line. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the building sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

M. Penalties

Any person violating any provisions of these standards shall be subject to penalties in accordance with Title 5, Article 1, Chapter 1, Section 16 of the City of Lawrence Municipal Code.

N. Appeals

All appeals will be addressed in conformance to the City of Lawrence Municipal Code, Title 5, Article 1, Chapter 6, Section 20.