

SANITARY SEWER SYSTEM DESIGN & CONSTRUCTION MANUAL

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APPROVAL EXPIRES
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TN. DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

CITY OF CHATTANOOGA, TENNESSEE
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
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I. PURPOSE

1. Intent

- 1.1 The intent of this manual is to provide guidelines and criteria for engineers, architects, developers, and contractors who plan, design, or construct projects that require new, relocated, or renovated sanitary sewer systems. This manual identifies the steps necessary to obtain city approval and acceptance of sanitary sewer system projects.
- 1.2 This manual is intended to provide specific requirements for the city's approval of gravity flow sanitary sewer collection systems with pipes 10 inches or less in diameter and pump stations and force mains with capacities less than 300 gallons per minute (gpm).
- 1.3 For all other types of sewer collection systems and for pump stations larger than 300-gpm capacity, submittal to and approval by the Tennessee Department of Environment and Conservation shall be required in addition to the city's approval.

2. Goals

- 2.1 The goals of providing standard sanitary sewer system design and construction standards include the protection and enhancement of the public health and the environment; the general welfare of the public with regard to future expenditures for operation and maintenance of the sanitary sewer system; and the best interest of the city with regard to the proper extension, modification, operation, and maintenance of the sanitary sewer system.

II. DEFINITIONS

1. AWWA - An abbreviation for American Water Works Association.
2. AASHTO - An abbreviation for American Association of State Highway and Transportation Officials.
3. ASTM - An abbreviation for American Society for Testing and Materials.
4. Backfill - The material placed in the trench from the top of the pipe encasement or cap up to the ground or subgrade level.
5. Carrier Pipe - Sanitary or storm sewer piping slipped inside the installed casing pipe.
6. Casing Pipe - Steel pipe with continuous circumferential buttwelded joints, jacked into position during the boring operation.
7. Construction Inspector - The individual who will provide the day-to-day, full-time inspection of a project under the direction of the engineer.
8. Contractor - The person(s) or firm hired by the developer to construct the infrastructure.
9. Engineer - The engineering firm responsible for the design of the sanitary sewer, pumping station, and force main.
10. Development - The land which is being converted to a particular use and for which the infrastructure is being constructed.
11. Developer - The person(s) or firm which owns the land which is being developed and who is responsible for the construction of the infrastructure.
12. DI - An abbreviation for ductile iron (piping).
13. Duplex - A pumping station containing two pumps.
14. Encasement - Class B concrete used to enclose a sewer in a trench. (Encasement shall extend at least 6 inches all the way around the outside of the exterior wall of the pipe being encased.)
15. Exfiltration - The exit of sewage through faulty joints or cracks in pipes or manholes.
16. Force Main - A pipe under internal pressure created by being on the discharge side of a pumping station.
17. Gate Valve - Manual, screw-type, pipe valves within the discharge piping that isolate one or both of the discharge pipes from the force main during maintenance.
18. GPM (gpm) - An abbreviation for gallons per minute.
19. Grout - A fluid mixture of cement, sand, and water that can be poured or pumped easily.
20. Guide Rail System - A device which allows the submersible pump motor unit to be installed in or removed from the wetwell without disconnecting any piping and without requiring personnel to enter the wetwell.
21. HDPE - An abbreviation for high density polyethylene (piping).
22. Infiltration - The entrance of groundwater into a sewer system through faulty joints or cracks in the pipes or manholes.
23. Invert - The lower portion of a sewer or structure; the portion which is below the springline and is concave upward. Also, the lowest point on the inside surface of a sewer, particularly in reference to the elevation or slope of the sewer.
24. Mandrel - A device used to check installed flexible pipe for excessive deflection (greater than 5%). A mandrel is specifically sized for the diameter of pipe to be tested. As the mandrel is pulled through the pipe, excessive deflection in the pipe will prevent its passage.
25. Manhole - A sewer appurtenance installed to provide: 1) access to sewers for inspection and maintenance; and 2) for changes in sewer direction, elevation, and grade.

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26. Maximum Dry Density - The maximum density obtained in a Proctor moisture-density test using a specific compactive effort and method of compaction specified by ASTM D 698 or ASTM D 1557.
 27. PVC - An abbreviation for polyvinyl chloride (piping).
 28. Plumber - The person(s) or firm that subcontracts with a builder to install the plumbing system in a building or house, including the lateral.
 29. Precast - That which is formed in a mold or formed and distributed by the manufacturer as a complete unit.
 30. Proctor Test - A laboratory compacting procedure whereby a soil at a known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit weight determined. The procedure is repeated for various water contents sufficient to establish a relation between water content and unit weight.
 31. RCP - An abbreviation for reinforced concrete pipe.
 32. Record Drawings - Engineering plans which have been revised to reflect all changes to the plans which occurred during construction.
 33. RPM - An abbreviation for revolutions per minute.
 34. Sanitary Sewer - A sewer that carries liquid and waterborne wastes from residences, commercial buildings, industrial plants, and institutions, together with minor quantities of ground, storm, and surface waters that are not admitted intentionally.
 35. SDR - Abbreviation for the standard dimension ratio expressed as the outside diameter of the pipe divided by the pipe wall thickness.
 36. Sewage - Largely the water supply of the common community after it has been fouled by various uses.
 37. Sewer, Collector - A line that receives wastewater directly from property sewer laterals and transports the wastewater to trunk sewers.
 38. Sewer, Lateral - A line from a single user to the collector sewer. A lateral is a sewer that has no other common sewers discharging into it.
 39. Sewer, Trunk - A line to which collector sewers are tributary.
 40. Sewer, Interceptor - A sewer that receives flow from two or more trunk sewers and includes flow from force mains, etc.
 41. Springline - The line on the outermost points on the side of a sewer. On a circular sewer, it would be the line on the points at half the diameter above the invert.
 42. Storm Sewer - A sewer that carries storm water and surface water, street wash and other wash waters or drainage, but excludes domestic wastewater and industrial wastes.
 43. Submersible Pumps - Submersible wastewater pumps are vertical, close-coupled, extra heavy-duty pump and motor units which are designed to operate beneath the liquid they are pumping.
 44. TDH - An abbreviation for total dynamic head.
 45. Telemetry - The transmitting of alarm and control signals from remote pump station controls to a central monitoring location.
 46. Valve Vault - Precast or cast-in-place concrete structure housing gate valves, check valves, and air release valves.

III. GENERAL ENGINEERING REQUIREMENTS

1. Purpose

- 1.1 The purpose of this chapter is to describe the engineering and procedural steps required by the City of Chattanooga from beginning to final acceptance of a sanitary sewer project. These criteria apply to the development of all facilities that discharge sanitary sewage as part of their normal operations. This would include but not be limited to subdivisions, trailer parks, apartments, resorts, schools, service stations, shopping centers, truck stops, motels, industrial waste systems, laundries, and car wash facilities.

2. Ownership

- 2.1 Wastewater collection and transport systems, including pumping stations and force mains, will not be approved for construction unless ownership and responsibility for operation of the completed system are transferred to and accepted by the City of Chattanooga. Under certain circumstances, an organization or a person may request approval for construction of wastewater collection and transport systems, provided the organization or person adopts and implements an acceptable long-term plan for ownership, operation, and maintenance of the system.

3. Permits

- 3.1 It is the owner's responsibility to obtain all necessary permits along streams or rivers, i.e., Corps of Engineers, TVA, or the Natural Resources Section of the Division of Water Pollution Control.

4. Requirement for Licensed Engineer

- 4.1 All engineering design reports, plans and specifications, and any other relevant technical information presented to the City of Chattanooga for approval must bear the stamp of a professional engineer licensed to practice in the State of Tennessee. The City Engineering Division cannot act as consulting engineers for owners, but assistance will be given insofar as possible in developing a suitable and economical project.

5. Existing Sanitary Sewer System Capacity

- 5.1 Construction of new sewer systems or extensions of existing systems will be allowed only when the downstream conveyance system and the receiving wastewater treatment facility are capable of adequately conveying or processing the added hydraulic and organic load.

6. Design Requirements

- 6.1 The goal of these design requirements is to promote the simplest system available that will meet the standards of the city while providing maximum ease of operation. While cost comparisons are important, long-term operability and reliability should be an overriding influence in design of sanitary sewer systems.
- 6.2 The design period should be 20 years unless growth of the area dictates other design parameters.

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- 6.3 As a minimum, the following items shall be considered in the design of the sanitary sewer system:
 - 6.3.1 Present and future water quality requirements;
 - 6.3.2 Local topography of the area being served by the sanitary sewer system;
 - 6.3.3 The immediate and downstream effects of industrial wastes that may be discharged into the new system;
 - 6.3.4 System capital costs;
 - 6.3.5 System operating and maintenance costs;
 - 6.3.6 Environmental impact on present and future adjacent land use.

7. Engineering Report

- 7.1 Every proposed addition to the sanitary sewer system of the City of Chattanooga shall be accompanied by an engineering report to explain the purpose of the proposed addition. The engineering report shall assemble basic information, present design criteria and assumptions, and offer conclusions and recommendations. The report must be sufficiently complete to facilitate further plan and specification development. The report shall identify and be consistent with all applicable areawide projects, drainage basins, service areas, comprehensive, and metropolitan area plans, e.g. 208 and 303(e) plans.
- 7.2 As a minimum, the engineering report shall include the following information:
 - 7.2.1 Purpose and need for the proposed project;
 - 7.2.2 Present and design population with the method of determination;
 - 7.2.3 Nature and extent of the area to be served, including immediate and probable future development;
 - 7.2.4 Description of the existing collection system, including general condition and known problems;
 - 7.2.5 Present basis of design, including reliable measurements or analysis of flow and wastewater constituents, and hydraulic, organic, and solids loadings attributed to residential, commercial, and industrial users;
 - 7.2.6 The 25-year and 100-year flood elevations and conditions;
 - 7.2.7 Sufficient soils and geologic data to evaluate site conditions, including borings for representative subsurface conditions when appropriate and identification of Karst feature;
- 7.3 The engineering report shall be submitted to the office of city engineer, and may be submitted alone or with the proposed construction plans and specifications. The city engineer will review and either approve or comment in writing on the report within 30 calendar days.

8. Plans and Specifications

- 8.1 All plans and specifications must be in accordance with the approved engineering report, and any changes must be approved in writing by the city engineer prior to construction. All plans and specifications for sanitary sewer systems shall show the following:
 - 8.1.1 The name, address, and phone number of the owner;
 - 8.1.2 The name, address, and phone number of the engineer;
 - 8.1.3 The seal and signature of the design engineer;
 - 8.1.4 The scale in feet;
 - 8.1.5 A north arrow;

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- 8.1.6 A location map;
 - 8.1.7 The date of submittal and any revision dates.
 - 8.2 The plans should be clear and legible and drawn to a scale which permits all necessary information to be shown plainly. Plan and profile sheets should be drawn on D size paper, 24 inches by 36 inches, and should use the standard format of the City of Chattanooga, which is shown as Figure III - 1, and can be downloaded at www.chattanooga.gov/pubworks/engineering/design/standards3-2001.pdf. Where practical, sanitary sewer lines shall be drawn with north to the top or to the left of the sheet. The plan view of the line shall be positioned directly above the profile view of the same line segment.
 - 8.3 The plans shall show the following information at a minimum:
 - 8.3.1 Profiles for sewer detail with a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch. Plan views should be drawn to a corresponding horizontal scale;
 - 8.3.2 Locations of streets and sewers;
 - 8.3.3 Lines of ground surface, pipe type and size, manhole stationing, invert and surface elevation at each manhole, and grade of sewer between adjacent manholes;
 - 8.3.4 Manholes should be labeled on the plan and also on the profile correspondingly. Where there is any question of the sewer being sufficiently deep to allow access by any point of entry, the elevation and location of the point of entry shall be plotted on the profile of the sewer which is to provide service to the point of entry;
 - 8.3.5 Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, check dams, and flow monitoring key manholes;
 - 8.3.6 Location of all existing structures below and above ground which might interfere with the proposed construction, including water mains, gas mains, storm drains, and telecommunications systems;
 - 8.3.7 Detail drawings of all stream crossings with elevations of the streambed and of normal and extreme high- and low-water levels to include 25- and 100- year floodplain;
 - 8.3.8 A topographic map with contours shown at 2-foot intervals, including trees over 4" caliper within 25 feet of centerline of the proposed sewer line.
 - 8.4 A general layout plan must be submitted for projects involving construction or substantial modification of pumping stations. The plan should show:
 - 8.4.1 The location of the pump station and the extent of the tributary area;
 - 8.4.2 A topographic map with contours shown at 2-foot intervals;
 - 8.4.3 The land use (commercial, residential, and agricultural) existing or proposed for the near future within a 500-foot radius of the pumping station. Existing buildings and their types within 100 feet of the pumping station property lines should be included;
 - 8.4.4 Elevation of groundwater at the site and maximum elevation of sewage in the collection system upon occasion of power failure;
 - 8.4.5 Test boring locations and test boring information;
 - 8.4.6 Plan and elevation views of the pump suction (from the wetwell) and discharge piping showing all isolation valves and gates.

9. Construction Specifications

- 9.1 Construction specifications supplement the plans by describing the intended project in additional detail relative to construction products and methods. The specifications shall conform to the city's standard specifications and shall include, but not be limited to, all construction information which is not shown on the drawings and is necessary to inform the contractor in detail of the design requirements relative to the quality of materials, workmanship and fabrication of the project, and the type, size, operating characteristics, and rating of equipment; machinery; valves, piping, and jointing of pipe; electrical apparatus, wiring, and meters; operating tools; construction materials; miscellaneous appurtenances; and testing for the completed systems.

10. Submittals

- 10.1 After written approval of the engineering report by the city engineer, the owner or his authorized representative shall submit five copies of complete construction plans and specifications of the proposed facilities to the city engineer for review and approval. Written approval must be received from the city engineer before construction can begin.
- 10.2 Each sheet of the plans shall be hand-dated with a copy of the seal and signature of the engineer. Only the title sheet and front cover of the specifications are required to be marked with original seal, signature, and date.
- 10.3 The city engineer will review and either approve or comment on the final plans and specifications within 30 calendar days. Three copies of plans and specifications will be retained by the city, with the remaining copies returned to the owner. One of the retained city copies will be forwarded to the Tennessee Department of Environmental and Conservation.
- 10.4 The City of Chattanooga requires that one stamped copy of the approved plans and specifications be on the construction site and available for inspection at all times during the construction process.

11. Revisions to Approved Plans

- 11.1 Any deviations from approved plans or specifications affecting capacity, flow, operation of units, or point of discharge shall be approved in writing by the city engineer prior to making any changes. Revisions to plans or specifications should be submitted at least 10 days in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Minor structural revisions will be permitted during construction with the concurrence of the design engineer. As-built plans clearly showing all alterations shall be submitted to the city at the completion of the work.

IV. COLLECTION SYSTEMS

1. Design

1.1 Sewer systems shall be designed and constructed to achieve total containment of sanitary wastes and maximum exclusion of infiltration and inflow. Combined sewers will be not be approved under any circumstances.

1.2 The following factors must be considered in the design of sanitary sewers:

1.2.1 Peak sewage flows from residential, commercial, institutional, and industrial sources;

1.2.2 Groundwater infiltration and exfiltration;

1.2.3 Topography and depth of excavation;

1.2.4 Treatment plant location;

1.2.5 Soils conditions;

1.2.6 Pumping requirements;

1.2.7 Maintenance, including manpower and budget;

1.2.8 Existing sewers;

1.2.9 Existing and future surface improvements;

1.2.10 Controlling service connection elevations.

2. Calculations

2.1 Computations and other data used for design of the sewer system shall be submitted to the city engineer as a part of the engineering report. Calculations for system capacity shall utilize the format shown in Table IV - 1 or an approved equivalent.

2.2 New sewer systems shall be designed on the basis of per capita flows or alternative methods. Documentation of the alternative methods shall be provided.

2.3 New sewer systems designed on the basis of an average daily per capita flow may be designed for flow equal to that set forth in Table IV - 2. These figures are assumed to cover normal infiltration and inflow, but an additional allowance should be made where conditions are unfavorable. If there is an existing water system in the area, water consumption figures can be used to help substantiate the selected per capita flow.

2.4 Generally, the sewers should be designed to carry, when running full, not less than the following:

2.4.1 Lateral sewers, submains, main, trunk and interceptor sewers should be designed with a minimum peak design flow as shown in Table IV - 3.

2.4.2 New sewer systems may be designed by alternative methods other than on the basis of per capita flow rates. Alternative methods may include the use of peaking factors of the contributing area, allowances for future commercial and industrial areas, separation of infiltration and inflow from the normal sanitary flow, and modification of per capita flow rates (based on specific data). Documentation of the alternative method used shall be provided. When infiltration is calculated separately from the normal sanitary flow, the maximum allowable infiltration rate shall be 25 gallons per day per inch-diameter of the sewer per mile of sewer.

TABLE IV- 2 DESIGN BASIS FOR NEW SANITARY SEWER CONSTRUCTION

Discharge Facility	Design Units	Flow (gpd)	BOD (lb/day)	TSS (lb/day)	Flow Duration (hr)
Dwellings	per person	100	0.17	0.2	24
School with showers and cafeteria	per person	16	0.04	0.04	8
School without showers and with cafeteria	per person	12	0.025	0.025	8
Boarding School	per person	75	0.2	.2	16
Motels at 65 gal/person (rooms only)	per person	130	0.26	.26	16
Trailer courts at 3 persons/trailer	per trailer	225	0.6	0.6	24
Restaurants	per seat	40	0.2	0.2	16
Interstate or through highway restaurants	per seat	180	0.7	0.7	16
Interstate rest areas	per person	5	0.01	0.01	24
Service stations	per vehicle serviced	10	0.01	0.01	16
Factories	per person per 8 hr shift	25	0.05	0.05	Operating Period
Shopping center (no food)	per 1,000 sq. ft. of ultimate floor	150	0.01	0.01	12
Hospitals	per bed	300	0.6	0.6	24
Nursing home (add 75 gals for laundry)	per bed	120	0.3	0.3	24
Homes for the Aged	per bed	60	0.2	0.2	24
Child Care Center	per child and adult	10	0.01	0.01	Operating period
Laundromats, 9 to 12 machines	per machine	250	0.3	0.3	16
Swimming pools	per swimmer	10	0.001	0.001	12
Theaters, auditorium type	per seat	5	0.01	0.01	12
Picnic areas	per person	5	0.01	0.01	12
Resort camps, day & night with limited plumbing	per campsite	50	0.05	0.05	24
Luxury camps with flush toilets	per campsite	100	0.1	0.1	24
Churches (no kitchen)	per seat	3	.005	0.005	Operating period

*Includes normal infiltration

Note: In all cases use actual data from similar facilities when possible. Note variations due to factors such as age, water conservation, etc. Submit all design data used.

TABLE IV - 3 PEAKING FACTORS

Average Daily Flow Rate (gpm)	Tributary Population	Ratio of Peak Instantaneous Flow Rate to Average Daily Flow Rate
< 70	< 1,000	4.0
> 70 but < 300	> 1,000 but < 5,000	3.5
> 300 but < 650	> 5,000 but < 10,000	3.0
> 650	> 10,000	2.5

3. Gravity Sanitary Sewers

- 3.1 The minimum pipe size in gravity sanitary sewer systems shall be 8 inches in diameter without a written variance from the city engineer.
- 3.2 Sanitary sewers located outside of roadways or other traffic loading should be installed with at least 30 inches of cover to the top of the pipe, and in all cases must be sufficiently deep to prevent physical damage from surface loading.
- 3.3 Sanitary sewers located in roadways or subject to other traffic loading should be installed with at least 48 inches of cover to the top of the pipe. In roadways where cover is less than 48 inches, DI pipe or concrete encasement shall be used. In all cases, a minimum of 6 inches of concrete encasement is required. Sewers installed greater than 18 feet in depth shall be DI.
- 3.4 DI pipe, concrete encasement, or relocation shall be required when culverts or other conduits are laid such that the top of the sewer is less than 18 inches below the bottom of the culvert or conduit.
- 3.5 Sanitary sewers larger than 3 inches in diameter which are located in roadways or subject to other traffic loading should be installed inside a steel protective casing.
- 3.6 The roughness coefficient should be documented for the type of pipe used. However, for ease of calculation, an "n" value of 0.0115 may be used in Manning's formula for the design of all new sewer facilities.
- 3.7 All gravity sanitary sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second. The allowable minimum slopes shown in Table IV - 4 should be provided; however, slopes greater than these are desirable. The desirable minimum slopes in Table IV-4 will provide a velocity of approximately 2.5 feet per second. Sewers shall be laid with uniform slope between manholes.

TABLE IV - 4 MINIMUM ALLOWABLE SLOPES

Sewer Size (inches)	Minimum Slope (feet per 100 feet)	Desirable Minimum Slope (feet per 100 feet)
8	0.26	0.40
10	0.193	0.28
12	0.151	0.22

- 3.8 Sewers on 18 percent slope or greater shall be anchored securely with concrete anchors or equal. Maximum anchorage spacing is 36 feet center to center on grades between 18 percent and 25 percent, 24 feet center to center on grades between 25 percent and 35 percent, and 16 feet center to center on grades that exceed 35 percent.
- 3.9 Where a smaller sewer line joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.
- 3.10 Where velocities greater than 15 feet per second are expected, special provision shall be made to protect against internal erosion or displacement by shock.
- 3.11 Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet on sewers 15 inches or less. Greater spacing may be permitted in larger sewers with a written variance from the city engineer and

provided it complies with State of Tennessee Department of Environment and Conservation Design Guidelines.

- 3.12 An outside drop connection shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.
- 3.13 The minimum inside diameter of manholes should be 48 inches, and larger diameters are preferable. The minimum clear opening in the manhole frame should be 24 inches to provide safe access. Manholes connecting significant industries to the system should be larger to provide space for monitoring and sampling equipment.
- 3.14 Flow channels in manholes shall be of such shape and slope to provide smooth transition between inlet and outlet sewers and to minimize turbulence. A minimum slope of 0.1 ft. drop across the bottom of the manhole must be provided to maintain cleaning and the hydraulic gradient. Channeling height shall be to the crowns of the sewers. Benches shall be sloped from the manhole wall toward the channel to prevent accumulation of solids.
- 3.15 Watertight manhole covers shall be used wherever the manhole tops may be flooded. Manholes of brick or segmented block are not acceptable. All new manholes shall be vacuum tested to assure watertightness. Ventilation of gravity sewer systems should be considered where continuous watertight sections greater than 1,000 feet in length are incurred. Vent height and construction must consider flood conditions.
- 3.16 Line connections directly to the manholes or to short stubs integral with the manholes should be made with flexible joints. Flexible joints are joints which permit the manholes to settle without destroying the watertight integrity of the line connections.
- 3.17 Materials
 - 3.17.1 Any generally accepted material for sewers will be given consideration. The material selected should be adapted to local conditions such as character of industrial wastes, possibility of septicity, soil characteristics, abrasion, and similar problems. Careful consideration should be given to pipes and compression joint materials subjected to corrosive or solvent wastes. Such pipe and compression joint material should be evaluated for vulnerability to chemical attack, chemical/stress failure, and stability in the presence of common household chemicals such as cooking oils, detergents, and drain cleaners.
 - 3.17.2 The specifications shall stipulate that the pipe interior, sealing surfaces, fittings, and other accessories should be kept clean prior to installation. Pipe bundles should be stored on flat surfaces with uniform support. Stored pipe should be protected from prolonged exposure (six months or more) to sunlight with a suitable covering (canvas or other opaque material). Air circulation should be provided under the covering. Gaskets should not be exposed to oil, grease, ozone (produced by electric motors), excessive heat and direct sunlight. The contractor should consult with the pipe manufacturers for specific storage and handling recommendations.
 - 3.17.3 Rigid Pipe: (Not approved for gravity sewers).
 - 3.17.4 Semi-rigid Pipe: Includes DI. Rubber gasket joints shall be specified. All pipe should meet the appropriate ASTM and/or ANSI specifications.
 - 3.17.5 Flexible Pipe: Includes PVC and HDPE. PVC pipe should have a maximum SDR of 35. All other flexible pipe that is not classified by the SDR system should have the same calculated maximum deflection under identical conditions as the SDR 35 PVC pipe. Flexible pipe deflection under earth loading may be calculated using the formula presented in the ASCE/WPCF publication; *Design and Construction of Sanitary and Storm Sewers*. All pipe should meet appropriate ASTM and/or ANSI specifications. It should be noted that ASTM D-3033 and D-3034 PVC pipes differ in wall thickness and have non-interchangeable fittings.

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- 3.18 Pipe Bedding: All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. Trench widths should be kept to a minimum. Backfill material up to 3 feet above the top of the pipe should not exceed 6 inches in diameter at its greater dimension.
- 3.18.1 As a general rule, in roadways where cover is less than 4 feet, DI pipe, solid wall flexible plastic pipe, or concrete encasement shall be used. In such cases, a minimum encasement thickness of 6 inches (12 inches for solid wall flexible plastic pipe) is required. For structural reasons, DI pipe, concrete encasement, or relocation shall be required when culverts or other conduits are laid such that the top of the sewer is less than 18 inches below the bottom of the culvert or conduit.
- 3.18.2 Uncased borings are not permitted for pipe larger than 3 inches.
- 3.18.3 Special care shall be used in placing bedding in the haunch region.
- 3.18.4 Rigid Pipe: (Not applicable).
- 3.18.5 Semi-rigid Pipe: Bedding Classes I, II, III or IV (ML and CL only) as described in ASTM D-2321 shall be used for all semi-rigid pipe provided with the specified bedding to support the anticipated load. Underground installation of DI shall be as per ASTM A-746.
- 3.18.6 Flexible Pipe: Bedding Classes I, II, or III as described in ASTM D-2321 shall be used for all flexible pipe, provided the proper strength pipe is used with the specified bedding to support the anticipated load. Bedding, haunching, initial backfill, and backfill shall be placed in accordance to ASTM D-2321. It is recommended that polyethylene pipe be installed with Class I bedding material for bedding, haunching, and initial backfill as described below.
- 3.18.7 Alternate Bedding Option: As an alternative to the above sub-sections, all sewers shall be bedded and backfilled with a minimum of 6 inches of Class I material over the top and below the invert of the pipe.
- 3.18.8 Deflection Testing: Deflection testing of all flexible pipe shall be required. The test shall be conducted after the backfill has been in place at least 24 hours. No pipe shall exceed a deflection of 5%. The test shall be run with a rigid ball or an engineer-approved 9-arm mandrel having a diameter equal to 95% of the inside diameter of the pipe. The test must be performed by manually pulling the test device through the line.
- 3.18.9 Check Dams: Check dams shall be installed in the bedding and backfill of all new or replaced sewer lines to limit the drainage area subject to the French drain effect of gravel bedding. Major rehabilitation projects should also include check dams in the design. Dams shall consist of compacted clay bedding and backfill at least 3 feet thick to the top of the trench and cut into the walls of the trench 2 feet. Alternatively, compacted 33P mix or concrete encasement may be used, keyed into the trench walls. Dams shall be placed no more than 500 feet apart. The preferred location is upstream of each manhole. All stream crossings will include check dams on both sides of the crossing.
- 3.19 Joints: The method of making joints and the materials used should be included in the specifications. Sewer joints shall be designed to eliminate infiltration and exfiltration to prevent the entrance of roots.
- 3.20 Elastomeric gaskets or other types of pre-molded (factory made) joints are required. The butt fusion joining technique is acceptable for polyethylene pipe. Cement mortar joints are not acceptable. Field solvent welds for PVC and polyethylene pipe and fittings are not acceptable.
- 3.21 Leakage Testing: Leakage tests shall be specified.
- 3.22 Testing Methods: Testing methods may include appropriate water or low pressure air testing. The use of television cameras for inspection prior to placing the sewer into service and prior to acceptance is recommended.

- 3.23 Low Pressure Air Testing: Low pressure air-testing shall be performed as per ASTM C-828 on all gravity pipe. The time required for the pressure to drop from the stabilized 3.5 psig to 2.5 psig should be greater than or equal to the minimum calculated test time. (The test criteria should be based on the air loss rate.) The testing method should take into consideration the range in groundwater elevations projected and the situation during the test. The height of the groundwater should be measured from the top of the invert (one foot of H₂O = 0.433 psi).

Table IV-5 gives the minimum test times and allowable air loss values for various pipe size per 100 ft.:

TABLE IV - 5 MINIMUM TEST TIMES AND AIR LOSS

Pipe Size (inches)	Time, T (sec/100 ft)	Allowable Air Loss, Q (ft ³ /min)
6	42	2.0
8	72	2.0
10	90	2.5
12	108	3.0

4. Protection of Potable Water Supplies

- 4.1 Physical connections between a public or private potable water supply system and a sanitary sewer or appurtenance thereto is prohibited.
- 4.2 Relation to Water Mains
- 4.2.1 Horizontal Separation: Whenever practical, sewers should be laid at least 10 feet horizontally from any existing or proposed water main. The distance should be measured edge to edge. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if it is laid in a separate trench and if the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.
- 4.2.2 Vertical Separation: Whenever sewers must cross under water mains, the sewer shall be laid at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
- 4.3 When it is impractical to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to the water main pipe and shall be pressure-tested to assure watertightness. Such arrangements are discouraged and adequate reason shall be provided to justify the design.
- 4.4 When it is impractical to obtain proper horizontal and vertical separation as stipulated above, the city engineer may grant a written variance to the separation requirements. If such a variance is granted by the city engineer, the sanitary sewer shall be designed and constructed with materials equal to the water main pipe and shall be pressure-tested to assure watertightness.

5. Location of Sewers in or near Streams

- 5.1 Sanitary sewer systems shall be designed to minimize the number of stream crossings. Sanitary sewer lines entering or crossing streams shall be constructed of DI pipe with mechanical joints, shall be concrete encased, or shall be so otherwise constructed that they will remain watertight.
- 5.2 Sanitary sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible. Changes in alignment or grade in a stream are not permitted.
- 5.3 The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, the following cover requirements must be met:
 - 5.3.1 1 foot of cover (poured in place concrete) is required where the sewer is located in rock;
 - 5.3.2 3 feet of cover is required in stabilized stream channels;
 - 5.3.3 7 feet of cover or more is required in shifting stream channels.
- 5.4 Sanitary sewer structures shall be located so they do not interfere with the free discharge of flow of the stream.
- 5.5 Check dams must be installed at all stream crossings, both upstream and downstream, in the pipe conduit trench. This must be separate from any concrete encasement.
- 5.6 Check dams must be installed every 500 feet where sanitary sewer runs parallel to streams.

6. Aerial Crossings

- 6.1 Sanitary sewer pipe attached to piers across ravines or streams shall be allowed when it can be demonstrated that no other practical alternative exists.
- 6.2 Support shall be provided for all joints. All supports shall be designed to prevent frost heave, overturning or settlement. Expansion jointing shall be provided between above-ground and below-ground sewers.
- 6.3 The bottom of the pipe should be placed no lower than the elevation of the 50-year flood stage.

7. Inverted Siphons

- 7.1 Inverted siphons shall not be permitted without special written permission by the city engineer.

8. Force Mains

- 8.1 Force mains should be not less than 4 inches in diameter, except for grinder pump applications, and should be constructed of pressure-rated PVC (minimum Class 200), HDPE (minimum SDR 17), or DI pipe.
- 8.2 A minimum self-scouring velocity of 2 feet per second should be maintained during pump operation (4 feet per second velocity is desired), and maximum velocity should not exceed 8 feet per second.
- 8.3 A sewage air relief valve shall be placed at all high points in the force main to relieve air locking.
- 8.4 Materials of Construction
 - 8.4.1 The pipe material should be adapted to local conditions, such as character of industrial wastes, soil characteristics, exceptionally heavy external loadings, internal erosion, corrosion, and similar problems.

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- 8.4.2 Installation specifications shall contain appropriate requirements based on the criteria, standards, and requirements established by the industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations, create excessive side fill pressures or ovalation of the pipe, or seriously impair flow capacity.
 - 8.4.3 All pipes shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the pipe shall be made because of the width and depth of trench.
 - 8.5 The force main shall enter the receiving manhole with its centerline horizontal and with an invert elevation that will ensure a smooth flow transition to the gravity flow section. The force main must enter the gravity sewer system at a point not more than 1 foot above the flow line of the receiving manhole. The design should minimize turbulence at the point of discharge.
 - 8.6 Protective coatings shall be installed in the receiving manhole to prevent deterioration as a result of hydrogen sulfide or other corrosive chemicals.
 - 8.7 Force mains shall be sufficiently anchored within the pump station and throughout the line length. The number of bends shall be minimized, and thrust blocks, restrained joints, and/or tie rods shall be provided where restraint is needed.
 - 8.8 Before backfilling, all force mains shall be tested at a minimum pressure of at least 50 percent above the design operating pressure for at least 30 minutes. Leakage shall not exceed the amount given by the following formula:

$$L = \frac{ND(P)^5}{7,400}$$

Where: L is allowable leakage in gallons per hour,
N is the number of pipe joints,
D is the pipe diameter in inches,
P is the test pressure in psi.

- 8.9 Force mains shall be sufficiently anchored within the pump station and throughout the line length. The number of bends shall be as few as possible. Thrust blocks, restrained joints, and/or tie rods shall be provided where restraint is needed.
- 8.10 Friction Losses: A "C" factor (surface roughness constant) shall be used that will take into consideration the conditions of the force main at its design usage. A pipe that is coated with grease after several years will not have the same C factor as it did when it was first placed into operation.
- 8.11 The force main design shall investigate the potential for the existence of water hammer.

9. Pump Stations

- 9.1 Sanitary sewage pump stations should be located as far as practicable from present or proposed residential areas. Noise control, odor control, and station landscaping design should be taken into consideration.
- 9.2 Where the wetwell is at a depth greater than the water table elevation, special provisions shall be made to ensure watertight construction of the wetwell. Design of the wetwell shall prevent the wetwell from floating.
- 9.3 A minimum of two submersible pump units shall be provided in each pump station, with each pump capable of handling the expected maximum flow. Pump head and system head curves shall

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- be submitted to the city engineer for review and written approval prior to construction. Submersible pumps must be from the city's approved list of pump manufacturers and models.
- 9.4 When the station is expected to operate at a flow rate less than one half the average design flow for an extended period of time, the design shall provide measures to prevent septicity due to extended holding times in the wetwell.
 - 9.5 All pumps, with the exception of grinder pumps, shall be capable of passing spheres of at least 3 inches in diameter. Pump suction and discharge openings shall be a minimum of 4 inches in diameter.
 - 9.6 Pumps shall operate under a positive suction head under normal operating conditions.
 - 9.7 Automatic pump control shall be provided such that pumps will come on and go off as the wetwell level rises and falls. Controls must activate standby pump if water in the wetwell continues to rise. Submerged pressure transducer controls are preferred for all sewage pump stations. Provisions should be made to automatically alternate the pumps in use. Each pump should be equipped with a secure external disconnect switch. Secondary (backup) float switches shall be provided, one for low wetwell level off and one for high wetwell level on. Float switches shall utilize an "intrinsically safe" power source.
 - 9.8 Flow meters shall be provided at all pumping stations with flow capacity greater than 100 gpm. Totalizers shall be provided with graduation in gallons.
 - 9.9 An alarm system for high wetwell levels, pump failures, and power failure shall be provided for each pump station. The system must provide compatibility with the city's telemetry system for relaying the alarm to the Moccasin Bend WWTP. A backup power supply shall be provided for the alarm system, such that a failure of the primary power source will not disable the alarm system.
 - 9.10 A riser from the force main with rapid connection capabilities and appropriate valving shall be provided for all lift stations to permit hook-up of portable pumps.
 - 9.11 Electrical systems and components shall comply with the National Electrical Code requirements for Class I Division 1 locations.
 - 9.12 Adequate lighting for the entire pump station site shall be provided.
 - 9.13 Provisions shall be made to facilitate removing pumps, motors, and other equipment, without interruption of system service.
 - 9.14 Suitable and safe means of access should be provided to equipment requiring inspection or maintenance. Manhole steps and ladders shall satisfy all OSHA requirements.
 - 9.15 Shutoff valves shall be placed on the discharge line of each pump for normal pump isolation. A check valve should be placed on each discharge line between the shutoff valve and the pump.
 - 9.16 Submersible pumps should be readily removable and replaceable without dewatering the wetwell or requiring personnel to enter the wetwell. Continuity of operation of the other units should be maintained.
 - 9.17 The control panel shall not be mounted on the wetwell but shall be within close proximity of the wetwell and suitably protected from weather, humidity, and vandalism. Control panel must include the following as a minimum:
 - a. NEMA 4X stainless steel enclosure, deadfront with hinged internal panel;
 - b. NEMA rated combination starter with ambient compensated overloads for each pump;
 - c. H-O-A switch and pump run light for each pump;
 - d. Non-reset elapsed time meter for each pump;
 - e. Duplex wetwell level controller with automatic pump alternator;
 - f. Individual alarm lights, hold-in relays, and reset pushbutton for the following:
 - (1) High and low wetwell levels;
 - (2) Overtemperature for each pump;

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- (3) Seal failure for each pump;
 - (4) Loss of phase/undervoltage;
 - g. Thermostatically controlled condensation heater;
 - h. External GFI duplex convenience receptacle;
 - i. Internal light with switch;
 - j. External red flashing alarm light;
 - k. External receptacle for portable generator with transfer switch;
 - l. Heavy duty oil-tight pilot devices (not miniature);
 - m. Lightning and surge protection;
 - n. Separate aluminum or stainless steel sun/rain shield;
 - o. Alarm terminal strip for connection to city telemetry system to monitor the following:
 - (1) Low level
 - (2) High level
 - (3) Power abnormality
 - (4) Pump No. 1 status
 - (5) Pump No. 2 status
 - (6) Pump No. 1 – seal fail
 - (7) Pump No. 2 – seal fail
 - (8) Pump No. 1 – motor overtemperature
 - (9) Pump No. 2 – motor overtemperature
 - (10) Control panel intrusion
 - (11) Pump failure to start or run
 - (12) Analog flow signal (for stations with flow meters)
- 9.18 All control valves on the discharge line for each pump should be placed in a convenient location outside the wetwell in separate pits and be suitably protected from weather and vandalism. A pressure gauge with shutoff valve shall be provided on the force main. The range of the gauge shall be from 0 to 150% of the pump's normal operating pressure.
- 9.19 All structures, including electrical and mechanical equipment, shall be protected from physical damage by the maximum 100-year flood, and shall remain fully operational during the 25-year flood.
- 9.20 All pumping stations shall be accessible by an all-weather road located at or above the 25-year flood elevation.
- 9.21 All accessories and hardware inside the wetwell shall be constructed of stainless steel or other corrosion-resistant materials.

V. CONSTRUCTION

1. Approval of Construction Documents

- 1.1 Upon written approval of the construction plans and specifications, the construction of additions or modifications of the sanitary sewer system can commence. The contractor must give 7 days' written notice to the city prior to beginning actual construction to allow the city adequate time to schedule construction inspection.
- 1.2 All construction shall be in conformance with the City of Chattanooga standard construction drawings and specifications for construction. The standard drawings are available on the internet at www.chattanooga.gov/pubworks/engineering/Standard_Dwgs/index.htm. The standard construction specifications are available on the City of Chattanooga internet web site at www.chattanooga.gov/pubworks/engineering/Standard_Specs/index.htm.

2. Final Inspection

- 2.1 All construction projects must have a final inspection to assure compliance with the approved plans and specifications. A written request for final inspection must be made by the contractor at least 2 weeks in advance of the scheduled date. The final inspection will be performed by the city accompanied by the contractor, engineer, and the owner.
- 2.2 After the final inspection is completed and all deficiencies noted during the inspection are corrected, the owner shall submit a written request for the city to accept ownership of the sanitary sewer system for operation and maintenance. The request for acceptance by the city shall be approved in writing by the city engineer, subject to the owner furnishing all required documentation, including as-built drawings, video inspection tapes, GIS information, electronic files, and manufacturer's operation and maintenance instructions. A copy of the detailed requirements for "Project Record Documents – Section 01720" is available on the internet at [www.chattanooga.gov/pubworks/engineering/Standard_Specs/01720 project record documents.pdf](http://www.chattanooga.gov/pubworks/engineering/Standard_Specs/01720_project_record_documents.pdf).

3. Transfer of Ownership

- 3.1 Owner must transfer the sanitary sewer system to the city as a complete system in good working order, free from any liens or encumbrances, and must transfer all easements and real property that are necessary for the operation and maintenance of the system.

VI. SANITARY SEWER PLANS CHECKLIST

- 1. Plans are stamped by a licensed professional engineer
- 2. Provide address and phone number of engineer
- 3. Flow determinations consistent with Tables IV-2 and IV-3
- 4. The receiving system has the capacity for the proposed flows
- 5. All geographical features shown, including detention ponds, etc.
- 6. Topography and elevations of all existing features shown
- 7. Topography and elevations of all proposed features shown
- 8. Contours at 2 ft. intervals
- 9. Direction of flow in streams indicated
- 10. 100-year flood elevation shown
- 11. Location, size and direction of existing sewers shown
- 12. Location, size and direction of proposed sewers shown
- 13. Plan and profile sheets at 1" = 50 ft. horizontal and 1" = 5 ft. vertical
- 14. Manhole numbers shown
- 15. Manhole stations shown
- 16. Deflection angles shown
- 17. Coordinates of manholes shown
- 18. Distance between manholes, pipe size, and slope shown on each line segment
- 19. Elevations conform to City of Chattanooga datum
- 20. Elevations shown at manhole inverts and rims
- 21. All existing utilities and structures, above and below ground shown
- 22. All easements indicated on plans
- 23. All utilities are shown in the easements
- 24. Easement widths are consistent with city's requirements
- 25. Conflicts (main lines or laterals) with the storm sewer or other utilities are identified
- 26. Laterals shown for each lot (No dual purpose laterals allowed)
- 27. 6 " laterals shown where required by plumbing code
- 28. No collector or trunk sewers are located in storm retention basins or their embankments, or the 10-year floodplain
- 29. Hydraulic design criteria followed, including velocities and slopes per Tables IV-3 and IV-4
- 30. Manhole design and location consistent with Section IV paragraph 3.0
- 31. Pipeline depth consistent with Section IV paragraph 3.0
- 32. Legends, vicinity map, north arrows, etc. shown
- 33. City's standard notes for public safety sewer construction noted
- 34. Date of preparation and revisions noted
- 35. Sewers abut at lot line to serve each tract (lot) without crossing another lot

PUMPING STATION PLANS CHECKLIST

- 1. Plans are stamped by a Licensed Professional Engineer
- 2. Flow determinations completed
- 3. Wetwell sizing is consistent with Section IV
- 4. Force main sizing is consistent with Section IV
- 5. Pump rate (gpm) and total dynamic head (TDH) are given
- 6. All geographical features shown
- 7. Subsurface information, as appropriate, is provided
- 8. Topography and elevations of all existing features shown
- 9. Topography and elevations of all proposed features shown
- 10. Contours at 2-ft. intervals
- 11. Direction of flow in streams indicated
- 12. 100-year flood elevation shown
- 13. Existing pumping stations, force mains, and trunk sewers within 1 mile radius of the proposed pumping station shown
- 14. Size, minimum grade of sewer at discharge point of force main is given
- 15. Location, size, and direction of existing sewers shown
- 16. Location, size, and direction of proposed sewers shown
- 17. Location, size, and direction of existing force mains shown
- 18. Location, size, and direction of proposed force main shown
- 19. Manhole numbers shown
- 20. Manhole stations shown
- 21. Deflection angles shown
- 22. Coordinates of manholes and pumping station shown
- 23. Distance between manholes, pipe size, and slope shown on each line segment
- 24. Benchmarks are shown
- 25. Elevations conform to City of Chattanooga datum
- 26. Elevations shown at manhole inverts and rims
- 27. All existing utilities and structures above and below ground shown
- 28. Property lines for the proposed pumping station property are indicated
- 29. All easements indicated on plans
- 30. All utilities shown in the easements
- 31. Legends, vicinity map, north arrows etc. shown
- 32. Access roads, parking, turnarounds are shown
- 33. Drainage is shown
- 34. Fencing of the site is shown
- 35. Landscaping is shown
- 36. Plan and section views sufficient to indicate what is to be built and what equipment is to be furnished
- 37. All equipment to be furnished is approved by the City of Chattanooga
- 38. Elevations are given for all structural components and operational levels of wetwell are called out
- 39. Painting is defined and/or specified
- 40. Telemetry system and alarm contact points consistent with existing City of Chattanooga SCADA system

APPENDIX A
STANDARD PROCEDURES FOR ACCEPTANCE
OF SANITARY SEWER SYSTEMS

1. PURPOSE

The purpose of this document is to standardize the procedures for acceptance of newly constructed or modified sanitary sewer systems into the City of Chattanooga regional wastewater collection and treatment system.

2. SANITARY SEWER DESIGN APPROVAL

The design of all new sanitary sewer systems proposed to be constructed in the City of Chattanooga shall be in conformance with the City of Chattanooga standard drawings and specifications for sanitary sewer construction, including the City of Chattanooga *Sanitary Sewer Design & Construction Manual*. Construction plans shall be approved in writing by the city engineer prior to beginning construction. Each set of plans shall require stamped approval by the city engineer. (Example of approval stamp shown in Attachment A). A copy of the stamped plans shall be maintained on site during construction.

3. NOTIFICATION OF CONSTRUCTION INITIATION

The contractor must give written notice to the city engineer of the intent to commence construction operations. This notice must be received by the city engineer at least 7 days prior to beginning construction to allow the assignment of appropriate personnel for construction monitoring and inspection.

4. CONSTRUCTION LOG

The contractor must maintain a daily construction log that documents the progress of the work. All unusual circumstances encountered during the construction operations shall be documented, along with any minor field changes. Major changes in the approved design will not be allowed without written approval by the city engineer. A copy of this log must be furnished by the owner to the city at the completion of the work, and will be a part of the documentation required for final acceptance by the city.

5. RECORD DRAWINGS

The owner shall submit to the city an electronic version of the sanitary sewer system as it was actually constructed, including horizontal and vertical locations of every manhole or other structure that was incorporated into the work. The as-built drawings shall be the true and accurate location and elevation of the structures shown, with a positional tolerance of 0.07 foot horizontal and 0.14 foot vertical. English units and NAD 83 state plane coordinates shall be used. Structures shall be identified by the number shown on the drawing or provided by the engineer. The electronic file, in ASCII format, shall provide the following minimum information for sanitary sewer manholes and drainage structures, including drainage manholes:

- a. Sanitary sewer manhole or drainage structure number.
- b. Northing, easting, and rim elevation.
- c. Invert elevation.
- d. Size, material, and direction for each pipe entering and leaving the sanitary sewer manhole or drainage structure.

6. TELEVISION LOGS

The owner shall submit to the city VHS videotapes of the television inspection conducted on the line as part of the final inspection process. The videotape must be accompanied by a hard copy written log that records the location of each connection to the new line.

7. EASEMENT DOCUMENTS

The owner shall submit to the city any and all documents required to provide for a permanent easement for access and maintenance to all sanitary sewer lines and related structures. The easement along sanitary sewer lines shall be a minimum of 20 feet in width, and shall be centered along the line. Larger easements for pump stations or other structures shall be provided as needed. No structures or permanent landscaping shall be located within dedicated easements.

8. FINAL INSPECTION

The owner shall submit a written request for final inspection to the city 14 days prior to the inspection date. The final inspection will be conducted with a representative of the owner, the contractor, the design engineer, and the city present. A list of corrective items will be prepared by the city and furnished to the owner, and a followup inspection will be scheduled after the required corrections are made. The owner will furnish a written statement to the city that the sanitary sewer system has been constructed and completed in substantial conformance with the original design documents, as may have been modified in writing with the consent of the city engineer.

9. FINAL ACCEPTANCE

Upon receipt of all the required documentation from the owner, including the construction logs, the record drawings, the television logs, the easement documents, and the certification from the owner that the project was constructed in substantial conformance to the approved design documents, the city engineer will issue a written statement of final acceptance to the owner. The owner will provide a full warranty to repair or replace any portion of the sanitary sewer system that may prove to be defective for a period of 365 days after the date of the letter of final acceptance by the city.

**ATTACHMENT A
SAMPLE APPROVAL STAMP**

APPROVED FOR CONSTRUCTION

THE DOCUMENT BEARING THIS STAMP HAS BEEN REVIEWED BY THE CITY OF CHATTANOOGA UNDER AUTHORITY DELEGATED BY THE TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION DIVISION OF WATER POLLUTION CONTROL, AND IS HEREBY APPROVED FOR CONSTRUCTION.

THIS APPROVAL SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF CORRECT OPERATION OR AS WARRANTING BY THE CITY OF CHATTANOOGA THAT THE APPROVED FACILITIES WILL REACH THE DESIRED GOALS.

APPROVAL OF THIS DOCUMENT EXPIRES 12 MONTHS AFTER THE DATE AFFIXED BELOW.

CITY ENGINEER

DATE

APPENDIX B
TECHNICAL SPECIFICATIONS

**APPENDIX B
TECHNICAL SPECIFICATIONS
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**SECTION 02120
VIDEO TAPING**

PART 1 – GENERAL

1.01 SCOPE

- A. The work covered by this section consists of furnishing all labor, equipment, and material required to provide a video tape record of all easement areas before construction begins in each area. One copy of the video tape(s) shall be presented to the Owner for their records.
- B. The purpose of the video tape(s) is to aid the Owner in determining the extent of construction damage to property in easement areas.

PART 2 – PRODUCTS

2.01 VIDEO TAPE

- A. The video tape shall be a standard VHS video cassette similar or equal to those produced by Sony, Fuji, or Scotchbrand.

PART 3 – EXECUTION

- A. Contractor shall use a quality video camera with sound available. The camera must have zoom capabilities, date record, and produce a clear, concise color picture of the easement area.
- B. Before construction begins, Contractor shall video record each easement by walking along the sewer alignment, recording all topographic features (i.e. trees, sheds, gardens, pools, fences, shrubs, buildings, walls, etc.) on line and also to the left and right of the centerline. The limits shall be determined by the Contractor and the Engineer as the area estimated to be disturbed by the construction.
- C. Contractor shall add sound to the video tape by denoting the line number, date and time, and stations at manholes or names and addresses or property owners.
- D. Contractor shall especially record and denote areas of existing damage prior to the construction (i.e. existing cracks in walls).

END OF SECTION

**SECTION 02220
EARTHWORK**

PART 1 - GENERAL

1.01 SCOPE

- A. This specification section includes earthwork and related operations, including, but not limited to, clearing and grubbing the construction site, dewatering, excavating all classes of material encountered, pumping, draining and handling of water encountered in the excavations, handling, storage, transportation, and disposal of all excavated and unsuitable material, construction of fills and embankments, backfilling around structures and pipe, backfilling all trenches and pits, compacting, all sheeting, shoring and bracing, preparation of subgrades, surfacing and grading, and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the work.
- B. The Contractor shall provide all services, labor, materials and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing a complete work as shown on the Drawings or specified in these Contract Documents.

1.02 GENERAL

- A. The elevations shown on the Drawings as existing are taken from the best existing data and are intended to give reasonable, accurate information about the existing elevations. They are not precise, and the Contractor should satisfy himself as to the exact quantities of excavation and fill required.
- B. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.
- C. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the Owner. All damage caused by erosion or other construction operations shall be repaired by the Contractor using material of the same type as the damaged material.
- D. If soil borings are available for the area of this work, they will be on file at the Owner's address where they will be made available for review. This information is made available to the Contractor for such use as he may choose to make of it in the preparation of his Bid, but the Owner gives no guarantee, either expressed or implied, that it represents a true or complete cross-section of all of the material to be encountered performing the excavation and earthwork on this project.

- E. Earthwork within the rights-of-way of the State Department of Transportation, the County Road Department, and the City shall be done in accordance with requirements and provisions of the permits issued by those agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these Specifications.
- F. The Contractor shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can be uninterrupted in existing gutters, other surface drains, or temporary drains. Material for backfill or for protection of excavation in public roads from surface drainage shall be neatly placed and kept shaped so as to cause the least possible interference with public travel. Free access must be provided to all fire hydrants, watergates, meters, and private drives.
- G. No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.
- H. Tests for compaction and density shall be conducted by the Engineer or by an independent testing laboratory selected by him. Costs of compaction tests performed by an independent testing laboratory shall be paid for directly by the Owner and not as a part of this Contract. The Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all retests made necessary by the failure of materials to conform to the requirements of these Contract Documents shall be paid by the Contractor.
- I. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the Engineer.
- J. It is understood and agreed that the Contractor has made a thorough investigation of the surface and subsurface conditions of the site and any special construction problems which might arise as a result of nearby watercourses and flood plains, particularly in areas where construction activities may encounter water-bearing sands and gravels or limestone solution channels. The Contractor shall be responsible for providing all services, labor, equipment, and materials necessary or convenient to him for completing the work within the time specified in these Contract Documents.

PART 2 - EXECUTION

2.01 INITIAL SITE PREPARATION

- A. Preparatory to beginning of construction operations, the Contractor shall remove from the site all vegetative growth, trees, brush, stumps, roots, debris, and any of other objectionable matter, including fences, buildings, and other structures shown on the Drawings in the construction areas which are designated for removal or which, if left in place, would interfere with the proper performance or completion of the contemplated work, would impair its subsequent use, or would form obstructions therein.
- B. Stumps and roots shall be grubbed and removed to a depth not less than 5 feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with compacted layers of crushed rock or earth backfill conforming to the requirements specified here for backfill. Organic material from clearing operations shall not be incorporated in excavation backfill or embankment material.
- C. The Contractor shall exercise special precautions for the protection and preservation of trees, cultivated shrubs, sod, fences, buildings, and other structures which are located in the construction area but not within designated clearing limits as shown on the Drawings or within the limits of embankments, excavations, or proposed structures. The Contractor shall be responsible for the repair and/or replacement of any of the aforementioned items damaged by his operation or construction activities.
- D. The Contractor shall remove and dispose of all excess material resulting from clearing or site preparation operations. The Contractor shall dispose of such materials in a manner acceptable to the Engineer and at an approved location where such materials can be lawfully disposed.

2.02 DEWATERING

- A. The Contractor shall provide and maintain at all times during construction ample means and devices with which to promptly remove and properly dispose of all water from any source entering the excavations or other parts of the work. Dewatering shall be accomplished by methods which will ensure a dry excavation and preservation of the final lines and grades of the bottoms of excavations. Methods of dewatering may include sump pumps, well points, deep wells, or other suitable methods which do not damage or weaken structures, foundations, or subgrades. Shallow excavations may be dewatered using open ditches provided such ditches are kept open and free-draining at all times. The actual dewatering methods used shall be acceptable to the Engineer.

- B. Unless specifically authorized by the Engineer, no concrete or mortar shall be placed in water nor shall water be allowed to rise over newly-placed concrete or mortar for at least 24 hours after placement. No concrete structure shall be exposed to unequal hydrostatic forces until the concrete has reached its specified 28-day strength. Water shall not be allowed to rise above bedding during pipe laying operations. The Contractor shall exercise care to prevent damage to pipelines or structures resulting from flotation, undermining, or scour. Dewatering operations shall commence when ground or surface water is first encountered and shall be continuous until such times as water can safely be allowed to rise in accordance with the provisions of this section. Excavations shall be protected from the entrance of surface water to the extent possible by the use of dikes and/or covers.
- C. Standby pumping equipment shall be on the job site. A minimum of one standby unit (a minimum of one for each ten in the event well points are used) shall be available for immediate installation should any pumping unit fail. The design and installation of well points or deep wells shall be suitable for the accomplishment of the work. Drawings or diagrams on proposed well point or deep well dewatering systems shall be submitted to the Engineer for review.
- D. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with crushed rock at no cost to the Owner.
- E. The Contractor shall dispose of the water from the work in a suitable manner without damage to adjacent property. Conveyance of the water shall be such as to not interfere with traffic flow or treatment facilities operation. No water shall be drained into work built or under construction without prior consent of the Engineer. The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
- F. Sedimentation and desilting basins shall be provided as necessary or when directed by the Engineer to prevent the entrance of excessive or injurious amounts of sand and silt from surface runoff or dewatering operations into storm drains or receiving waters. The system used for desanding or desilting the water shall be a baffled structure and shall provide not less than five minutes detention time and shall be designed to have a "flow-through" velocity not exceeding 0.2 feet per second at the anticipated peak flow. The method of desanding or desilting and the point of disposal shall be subject to the approval of the Engineer.
- G. Water shall be disposed of in such a manner as not to be a menace to the public health and in accordance with applicable Environmental Protection Agency, Corps of Engineers, and State Water Quality Control Division standards and permits, and the Storm Water Division of the Department of Public Works, City of Chattanooga, Tennessee.

2.03 SHEETING, SHORING, AND BRACING

- A. The sides of all excavations shall be sufficiently sheeted, shored, and braced as necessary to prevent slides, cave-ins, settlement or movement of the banks, to maintain the excavation clear of all obstructions, and to provide safe working conditions. Wood or steel sheeting of approved design and type shall be used in wet, saturated or flowing ground. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and to maintain shape and position under all circumstances.
- B. The responsibility for correctly assessing the need for sheeting and analyzing the stresses induced shall be the total responsibility of the Contractor. Since the Engineer does not dictate or determine the Contractor's sequence or limits of excavation, the Engineer assumes no responsibility for sheeting and shoring. The Contractor must employ or otherwise provide for adequate professional structural and geotechnical engineering supervision to assess the need for sheeting and shoring and design same. Results of sheeting and shoring analysis and design shall be submitted to the Engineer on request.
- C. Excavations adjacent to existing or proposed buildings and structures, or in paved streets or alleys shall be sheeted, shored, and braced adequately to prevent undermining beneath or subsequent settlement of such structures or pavements. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition. Any damage to structures or pavements occurring through settlements, water or earth pressures, slides, caves, or other causes; due to failure or lack of sheeting or bracing, or due to improper bracing; or occurring through negligence or fault of the Contractor in any other manner shall be repaired by the Contractor at his own expense.
- D. Sheeting, shoring, or bracing materials shall not be left in place unless otherwise specified or shown on the Drawings or ordered by the Engineer in writing. Such materials shall be removed in such manner that no danger or damage will occur to new or existing structures or property, public or private, and so that cave-ins or slides will not take place. Trench sheeting shall be left in place until backfill has been brought to a level 12 inches above the top of the pipe. It shall then be cut off and the upper portion removed. Sheeting for structures shall be left in place until backfill has been brought to a level of 12 inches above the top of the bottom footing. It shall then be cut off and the upper portion removed.

- E. All holes and voids left in the work by the removal of sheeting, shoring, or bracing shall be filled and thoroughly compacted.

2.04 EXCAVATION

A. GENERAL

1. Excavation shall include the removal of all material from an area necessary for the construction of a pipeline, structure, basin, flume, or building. Excavations shall provide adequate working space and clearances for the work to be performed therein.

2. Except where otherwise shown on the Drawings, specified herein, or authorized by the Engineer, all material excavated below the bottom of concrete walls, footings, and foundations shall be replaced, by and at the expense of the Contractor, with Class B Concrete to the lines and grades shown on the Drawings.

3. Where quicksand, soft clay, spongy, swampy, or other materials unsuitable or subgrade or foundation purposes are encountered below the excavation limits, they shall be removed and disposed of to the level of suitable material. Areas so excavated shall be backfilled with Class B Concrete or with compacted layers of crushed rock, sand, or other approved material conforming to the requirements specified herein for backfill to the lines and grades shown on the Drawings.

4. Barriers shall be placed at each end of all excavations and at such places as may be necessary along excavations to warn all pedestrian and vehicular traffic of such excavations. Lights shall also be placed along excavations from sunset each day to sunrise of the next day until the excavations are backfilled. All excavations shall be barricaded in such a manner to prevent persons from falling or walking into any excavation.

B. ROCK EXCAVATION

1. Rock encountered in the process of excavation for structures shall be uncovered and stripped of all loose materials over the entire limits of excavation. Rock encountered for removal in a trench section shall be uncovered for a distance of not less than 50 feet.

2. Rock and large boulders in trenches shall be excavated over the horizontal limits of excavation and to depths as shown on the Drawings.

3. The space below grade for pipe lines shall then be backfilled to the proper grade with compacted layers of crushed rock or sand conforming to the

requirements specified herein for backfill. Where pipe sewers are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the Drawings.

4. Rock under structures shall be excavated to lines and grades shown on the Drawings. Unless specified otherwise, where rock excavation has been carried below grade, the contractor shall backfill to grade with Class B concrete at his own expense.
5. Where rock foundation is obtained at grade for over 50 percent of the area of any one structure, the portion of the foundation that is not rock shall be excavated below grade to reach a satisfactory foundation of rock. The portion below grade shall be backfilled with Class B Concrete.
6. Where rock foundation is obtained at grade for less than 50 percent of any one structure and satisfactory rock cannot be found over the remaining area by reasonable additional excavation, the rock shall be removed for a depth of 12 inches below grade and the space below grade shall be backfilled to the proper grade with compacted layers of crushed rock conforming to the requirements specified herein for backfill.
7. Drilling and blasting operations shall be conducted with due regard for the safety of persons and property in the vicinity and in strict conformity with requirements of all ordinances, laws and regulations governing blasting and the use of explosives. Rock excavation near existing pipelines or other structures shall be conducted with the utmost care to avoid damage. Injury or damage to other structures and properties shall be promptly repaired to the satisfaction of the Owner by the Contractor at his own expense.
8. Rock excavation for all structures and adjacent trenches under this Contract and any other rock excavation directed by the Engineer shall be completed before the construction of any structure is started in the vicinity.

C. BORROW EXCAVATION

1. Wherever the backfill of excavated areas or the placement of embankments or other fills requires specified material not available at the site or material in excess of suitable material available from the authorized excavations, such material shall be obtained from other sources. This may require the opening of borrow pits at points not immediately accessible from the work. In such cases the Contractor shall make suitable arrangements with the property owner and shall pay all costs incident to the borrowed material including royalties, if any, for the use of the material. Before a borrow pit is opened, the quality and suitability of the material to be obtained there from shall be approved by the Engineer.

2. Borrow pits shall be cleared, grubbed and finish graded in accordance with the requirements specified herein.

D. ROADWAY EXCAVATION

Roadway excavation shall consist of excavation for roadways and parking areas in conformity with lines, grades, cross sections, and dimensions shown on the Drawings. After shaping to line, grade, and cross section, the subgrade shall be rolled until compacted to a depth of at least 6 inches to 100 percent of the maximum density at optimum water content as determined by AASHTO T 99, Method A. This operation shall include any reshaping and wetting required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

E. TRENCH EXCAVATION

1. Trench excavation shall consist of the removal of materials necessary for the construction of water, sewer, and other pipelines and all appurtenant facilities including manholes, inlets, outlets, headwalls, collars, concrete saddles, piers and pipe protection called for on the Drawings.
2. Excavation for pipelines shall be made in open cut unless shown otherwise on the drawings. Trenches shall be cut true to the lines and grades shown on the Drawings or established by the Engineer on the ground. The banks of trenches shall be cut in vertical, parallel planes equidistant from the pipe centerline. From an elevation 12 inches above the top of the pipe to the bottom of the trench, the horizontal distance between vertical planes for different sizes of pipe shall not exceed those shown on the Drawings. When sheeting is used, the width of the trench shall be considered as the distance between the inside faces of the sheeting. The bottom of the trench shall be cut carefully to the required grade of the pipe except where bedding materials or cradles are shown, in which case the excavation shall extend to the bottom of the bedding or cradles as shown on the Drawings. Minimum pipe cover shall be as shown on the Drawings or specified in these Contract Documents.
3. The use of a motor-powered trenching machine will be permitted but full responsibility for the preservation, replacement, and/or repair of damage to any existing utility services and private property shall rest with the Contractor.
4. Bell holes for bell and spigot pipe and/or mechanical joint pipe shall be excavated at proper intervals so the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of all joints in the pipe. Bell holes shall not be excavated more than 10 joints ahead of pipe laying. No part of any bell or coupling shall

be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

5. Excavation for manholes, outlets, collars, saddles, piers, and other pipeline structures shall conform to the additional requirements specified herein for structural excavation.

6. Pipe trenches shall not be excavated more than 400 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

7. Unless otherwise specified herein or shown on the Drawings, wherever pipe trenches are excavated below the elevation shown on the Drawings, the Contractor, at his own expense, shall fill the void thus made to the proper grade with Class B Concrete or with compacted layers of crushed rock or sand conforming to the requirements specified herein for backfill.

8. In all cases where materials are deposited along open trenches they shall be placed so that no damage will result to the work and/or adjacent property in case of rain or other surface wash.

F. STRUCTURAL EXCAVATION

1. Structural excavation shall consist of the removal of all materials necessary for the construction of structures, including tanks, foundations, footings, wetwells, dry wells, box culverts, flumes, channels, buildings, and other miscellaneous structures.

2. The bottom of structural excavations shall be true to the lines and grades shown on the Drawings. Faces of excavations shall not be undercut for extended footings.

Except as provided herein for excavation of unsuitable material or rock, where the excavation is carried below the grade elevation shown on the Drawings, the Contractor shall backfill the void thus made to the proper grade with Class B concrete at his own expense.

2.05 BACKFILLING

A. MATERIALS

Materials for backfilling shall conform to the following requirements:

1. SELECT EARTH BACKFILL

Fine, sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete less than 2 inches in maximum dimension except that the maximum particle size shall be 3/4 inch when used with PVC, other flexible thermoplastic pipe, or extremely brittle pipe.

2. COMMON EARTH BACKFILL

Sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete and pavement less than 6 inches in maximum dimension. Such backfill shall be placed a minimum of one foot above top of pipe.

3. SAND

Natural or imported sand conforming to ASTM D1073.

4. CRUSHED ROCK

Crushed rock conforming to Class A aggregate as specified in Section 903.05 and Section 903.22, Size 7 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction.

5. CLASS B CONCRETE

Class B concrete as specified in the Section entitled "Cast-In-Place Concrete" of these Specifications.

B. GENERAL

1. Unless otherwise specified herein, earth backfill shall be compacted to not less than 90 percent of the maximum density at optimum water content as determined by AASHTO T-99, Method A. Crushed stone and sand shall be compacted or consolidated to not less than 83 percent of the solid volume density as determined from the bulk specific gravity by AASHTO T-84 AND T-85 and the dry weight of the aggregate.

2. Material that is too dry for adequate compaction shall receive a prior admix of sufficient water to secure optimum moisture content. Material having excessive water content shall not be placed at any time.

3. Unless otherwise specified herein backfill material required to be compacted shall be placed in horizontal layers not to exceed 6 inches in thickness (before compaction) and compacted in place by ramming, tamping, or rolling. Compaction shall be accomplished by power driven tools and machinery wherever possible. Compaction and consolidation of sand and crushed rock backfill shall be accomplished using vibrating equipment in a manner acceptable to the Engineer.

C. BACKFILLING TRENCHES

1. The backfilling of sewer, water, and other pipeline trenches shall be started immediately after the construction of same has been inspected and approved by the Engineer. Select backfill or bedding material if specified shall be placed in the trench under and on each side of the pipe in 6-inch layers for the full width of the trench and thoroughly and uniformly compacted by ramming and/or tamping to a minimum of 90% of the maximum density determined as specified herein. Select earth backfilling shall start above the class of pipe bedding as specified or shown the Drawings. Sufficient select earth backfill shall be placed around the pipe and compacted to provide a cover of not less than 12 inches over the top of the pipe. Mechanical compactors or tampers shall not be used within 12 inches of pipe. Compaction in this area shall be accomplished by hand methods. Sand or specified crushed stone bedding material shall be substituted for select earth backfill when the pipe is bituminous coated steel pipe or wrapped steel pipe or when crushed stone trench backfill is required. Backfilling shall proceed simultaneously on both sides of the pipe to prevent lateral displacement.

2. Caution shall be used during backfill operations for PVC or other flexible thermoplastic pipe (non-pressure or sewer pipe) to prevent pipe deformation. PVC or other flexible thermoplastic pipe (sewer pipe) shall not be subjected to roller or wheel loads until a minimum of 36 inches of backfill has been placed over the top of the pipe and a hydrohammer shall NOT be used until a minimum depth of 48 inches backfill has been placed over the top of the pipe.

3. Backfilling of PVC pressure pipe or other flexible thermoplastic pipe (water pipe) shall be as described in Paragraph 1 above.

4. In streets, alleys, across sidewalks and driveways, paved areas, and at any other places subject to vehicular traffic

or other superimposed loads, crushed rock backfill shall be placed and compacted in 6-inch layers from the level of 12 inches above the top of the pipe upward for the full depth of the trench, except for the top 48 inches of backfill, which shall be compacted pugmill mix. Crushed rock shall be clean, uniform-sized stone placed in lifts of 6 inches maximum and compacted by use of a hydrohammer or approved vibratory compactor for the full depth of the trench, except for the top 48 inches of crushed rock backfill, which shall be compacted pugmill mix.

5. Trenches under concrete slabs and footings of structures shall be completely backfilled with compacted sand or crushed rock or filled with Class B concrete as shown on the Drawings.
6. In all other areas not affected by superimposed loads, common earth backfill may be placed from a level of 12 inches above the top of pipe upward for the full depth of the trench without compaction. At these places, backfill shall be neatly rounded over the trench to sufficient height to allow for settlement to grade after consolidation. In no event, however, will storm water be allowed to pond due to the backfilled trench.
7. All backfilling shall be done in such a manner that the pipe or structure over or against which it is being placed will not be disturbed or injured. Any pipe or structure injured, damaged, or moved from its proper line or grade during backfilling operations shall be removed and repaired to the satisfaction of the Engineer and then rebackfilled.

D. BACKFILLING AROUND STRUCTURES

1. Backfilling around structures shall consist of common earth backfill placed in 6-inch layers and compacted by tamping to a minimum of 90% of the maximum density determined as specified herein for the full depth of the excavation from the bottom to the finished grade. No backfill shall be placed against concrete structures until the concrete has reached its specified 28-day compressive strength. Where practical, compaction of structural backfill shall be accomplished by power-driven tamping equipment.
2. Where crushed rock mats under slabs and foundations are called for on the Drawings, the Contractor shall excavate below grade to the depth of the crushed rock mat as shown on the Drawings and shall install a compacted crushed rock bed. This shall be finished to a true line or plane and even with the subgrade of

the concrete foundations, piers, footings or slabs. Before placing any crushed rock, all loose earth or debris shall be removed. This crushed rock mat shall extend 12 inches beyond all slabs and foundations or to edges of sheet piling.

3. Crushed rock mats, 12 inches or less in thickness shall be constructed of compacted layers of crushed rock conforming to Section 903.22, Size Number 67 (3/4-inch to No. 4), of the Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction.

4. Crushed rock mats of thickness greater than 12 inches shall have the top 12 inches constructed of compacted layers of crushed rock as specified above. That portion below the top 12 inches shall be constructed of compacted layers of crushed rock conforming to Section 903.05, Class A, with a modified gradation of 6 inches to dust as received from the crusher.

5. Unless otherwise shown on the Drawings, the use of earth backfill to support footings, foundations, and structures shall not be permitted.

2.06 FILLS AND EMBANKMENTS

A. Fills and embankments shall consist of all earth fills except backfills in trenches or around structures. Unless special material is specified or shown on the Drawings, material for fills and embankments shall consist of excavated material from structures or of a mixture of such excavated materials and materials borrowed from other sources by the Contractor. All material used for fills and embankments shall be free from wood, vegetable matter, debris, soft or spongy earth or clay, large rock, or other objectionable material and shall be acceptable to the Engineer.

B. Material shall be placed in the fill or embankment in successive layers 6 inches or less in thickness before compaction, each layer being approximately horizontal and extending to the full limit of the required cross section and shall be compacted at optimum water content over the entire surface to not less than 95% of the maximum density as determined by AASHTO T-99, Method A. The process shall be repeated for each layer of material until the fill or embankment conforms to the plan lines, grades, and cross-sections. The degree of compaction and moisture content required, the method of tamping, and the equipment used shall be approved by the Engineer.

C. The area over which the fill or embankment is to be constructed shall first be cleared of all vegetation, debris, and other objectionable material and, if the ground is in a loose, uncompacted condition, it shall be compacted to a maximum density determined as specified herein.

D. No material shall be placed beyond the sloping lines of embankment unless so ordered by the Engineer. Material allowed to be placed beyond the lines of embankment shown on the Drawings will be compacted as required above unless otherwise authorized by the Engineer.

E. Material for embankments or roadway fills shall be placed in 6-inch maximum lifts and shall be compacted by rolling with power rollers weighing not less than 10 tons, with sheeps foot rollers, with vibrating rollers, or with pneumatic tire rollers, as required to accomplish the work. While and as each layer is deposited, water shall be applied in sufficient amount to ensure optimum moisture to secure the compaction specified.

F. The use of truck, carryalls, scrapers, tractors, or other heavy hauling equipment shall not be considered as rolling in lieu of rollers, but the traffic of such hauling equipment shall be distributed over the fill in such a manner as to make the use of the compaction afforded thereby as an addition to compaction by the use of rollers.

G. Wherever a trench passes through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation 12 inches above the top of the pipe before the excavation of the trench begins.

H. On subgrades for all roadbeds, the density for the top 6 inches of the finished subgrade shall be equal to not less than 100% of the maximum density as determined by AASHTO T-99, Method A. When field tests show failure to meet the density requirement, the subgrade shall be loosened by disking, harrowing or other approved methods to a depth of not less than 6 inches, then reshaped and recompacted as indicated in this paragraph.

2.07 DISPOSAL OF WASTE AND UNSUITABLE MATERIALS

A. All materials removed by excavation, which are suitable for the purpose, shall be used to the extent possible for backfilling pipe trenches, foundation, and footings and for making embankment fills or for such other purposes as may be shown on the Drawings. All materials not used for such purposes shall be considered as waste materials and the disposal thereof shall be made by the Contractor in a manner and at locations subject to the approval of the Engineer.

B. Waste materials shall be spread in uniform layers and neatly leveled and shaped. Spoil banks shall be provided with sufficient and adequate openings to permit surface drainage of adjacent lands.

C. Unsuitable materials, consisting of wood, vegetable matter, debris, soft or spongy clay, peat, and other objectionable material so designated by the Engineer shall be removed from the work site and disposed of by the Contractor in a

manner and at a location approved by the Engineer.

D. No unsuitable or waste material shall be dumped on private property unless written permission is furnished by the Owner of the property and unless a dumping permit is issued from the local jurisdiction.

2.08 FINAL GRADING

A. After other earthwork operations have been completed, the sites of all structures, roads, and embankments shall be graded within the limits and to the elevations shown on the Drawings. Grading operations shall be so conducted that materials shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in smooth and uniform planes such as are normally obtainable from the use of hand tools. If the Contractor is able to obtain the required degree of evenness by means of mechanical equipment he will not be required to use hand labor methods. Slopes and ditches shall be neatly trimmed and finished to slopes shown on the Drawings unless otherwise approved by the Engineer.

B. Unless otherwise specified or shown on the Drawings, all finished ground surfaces shall be graded and dressed to present a surface varying not more than plus or minus 0.10 foot as regards local humps or depressions and shall be acceptable to the Engineer.

2.09 TOPSOIL

A. All areas to be sprigged or planted with trees, shrubs, or grass as shown on the plans shall be prepared by grading to a smooth, even surface to a level 4 inches or other specified depth below the elevation of the finished grade shown on the Drawings. It shall then be brought to a neat and finished grade by the addition of 4 inches or other specified depth of approved topsoil as specified or directed in Section 02485.

B. Topsoil removed from the construction area may be stockpiled and reused or topsoil may be obtained from approved borrow areas. If obtained from borrow areas, the Contractor shall make suitable arrangements with the property owner and shall pay all costs incident to the borrowed material including royalties.

2.10 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within one (1) year after final acceptance of the work by the Owner.

B. The Contractor shall make, or cause to be made, all repairs or replacement made necessary by settlement within 30 days after receipt of written notice from the Engineer or Owner.

2.11 PREVENTION OF BLASTING DAMAGE

A. GENERAL

The Contractor shall be responsible for all property damage and personal injury caused by blasting for excavation work on this project. This includes events in which flying debris, air blast, or ground vibrations cause personal injury or property damage.

B. PREVENTING DAMAGE BY FLY-ROCK

A qualified Explosive Engineer and experienced Powder Foreman shall be available to direct and supervise the design of the blasting work. This shall consist of selecting the correct burden, spacing and stemming dimensions for the explosives used and the rock being blasted. This includes, but is not limited to, controlling water in the blast hole and using the proper stemming. The objective is to select the optimum blast dimensions which ensure that just enough explosive is available to break the rock, and that there is no excess explosive to propel the rock fragments beyond safe limits.

Blasting mats and/or backfill materials shall be used for each "shot" to help confine the limits of fly-rock in populated areas.

Traffic and access to blasting areas shall be closed off and blasting signals audible for 2,000 feet shall be sounded in time for all workers and nearby residents to get under cover. Also, residents immediately adjacent to a blast should be notified personally before any blast occurs.

C. PREVENTING DAMAGE BY AIR BLAST

Design measures shall be taken to reduce or control air blast to levels below which actual damage will not occur. Microphones to which a metering device is attached to record over pressure levels shall be used to monitor air results of all blasts. These records shall be filed and maintained throughout the construction of the project.

The use of detonating cord on the surface shall be avoided.

The use of sufficient burden, spacing and stemming to prevent the premature release of explosive gases shall be required for all blasting in closely populated areas.

The specific gravity of stemming material shall always be equal to or greater than that of the rock, and its length equal to 0.7 of the burden. The shape of the stemming material shall be coarse and angular.

There should be no top priming of any holes.

Decking shall be used to bridge limestone cavities or other weak areas in any hole.

In closely populated areas, all blast shall be designed to limit the peak particle velocity to less than two (2) inches per second.

D. PREVENTING DAMAGE BY GROUND VIBRATIONS

The Explosive Engineer and Powder Foreman shall design each "shot" to obtain the desired fragmentation without providing extra explosives which could be used to produce ground vibrations. In closely populated areas where old residential or auxiliary structures in poor condition exists, the two (2) inches per second peak particle velocity limit shall be lowered. Monitoring of these structures with seismographs shall be required and the data filed and maintained for the duration of the project.

Delay intervals such as millisecond caps or millisecond connectors shall be used to reduce the vibration effects of large blasts to the range of smaller charges at reduced peak particle velocity.

Tight confined shots that require increased powder charges shall not be attempted.

Excessive sub-drilling shall not be permitted.

In decking charges where small weights of powder are used, the inert material between decks shall be one (1) to two (2) feet thick.

The use of sensitive explosives such as straight dynamite shall not be permitted.

In drilling blast holes with cavities, the driller shall measure the depth and size of each cavity encountered. This log shall be used by the Powder Foreman in loading the explosive in the rock parts and filling with the stemming material in cavity parts.

Delay pattern shall be designed to provide maximum amount of free faces which reduces the amount of energy-transfer in ground vibrations.

Where potential settlement of a structure is involved, a pre-split line shall be required to help reduce the peak particle velocity beneath the structure to be protected.

**SECTION 02242
CLAY OR FLOWABLE MORTAR FILL FOR CUTOFF WALLS**

PART 1 - GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, equipment, and materials to form a cutoff consisting of flowable mortar fill or clay material at the location shown on the Drawings or as directed by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FLOWABLE MORTAR FILL

A. Materials used in this construction shall meet the following requirements:

Material	Specification
Portland Cement Type 1	AASHTO M 85
Fly Ash, Class C or Class F	AASHTO M 295
Water Potable	
Chemical Additives	AASHTO M 194

B. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves, shall conform to the following requirements:

Sieve Size	Total Percent Passing by Weight
3/4-inch	100
No. 4	95-100
No. 16	50-90
No. 50	10-30
No. 200	0-10

2.02 PROPORTIONING FOR FLOWABLE MORTAR FILL

A. Flowable mortar shall be proportioned as follows:

Material	Per Cubic Yard
Portland Cement, Type 1	100 lbs. (maximum)
Fly Ash, Class C or F	250 lbs. (minimum)
Fine Aggregate	2,800 lbs.
Water	60 gals. (approximate)

- B. The above proportions may be adjusted by the Engineer to obtain the consistency required for satisfactory flow. Consistency shall be determined as follows:

Place an open-ended cylinder (pipe) 3 inches in diameter by 6 inches in heights in an upright position on a smooth, level surface. Fill the cylinder with a representative sample of the flowable mortar proposed for use. Remove the cylinder by lifting it straight up thus allowing the sample to diffuse on the smooth, level surface. the flowable mortar should diffuse into a circular shape having an approximate diameter of not less than 8 inches.

2.03 FOR CLAY CUTOFF WALL

- A. Clay material shall have no organic material.
- B. Clay material shall be compacted to 95 percent Standard Proctor.

PART 3 - EXECUTION

3.01 GENERAL

- A. Flowable mortar shall be used where cutoffs are required and the area is in streets, alleys, across sidewalk and driveways, and at any other place subject to vehicular traffic or other superimposed loads.
- B. Installation of cutoffs shall be according to "Backfilling Trenches" in Section 02220, "Earthwork."
- C. The flowable mortar shall be covered or otherwise protected while in the plastic state. Backfill shall not be placed on the flowable mortar prior to final set or hardening as determined by the Engineer.
- D. Cutoff material shall be placed from bottom of trench to top of ground.

END OF DOCUMENT

SECTION 02270
SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

1.01 SCOPE

- A. This section shall consist of temporary control measures as shown in the plans or directed by the ENGINEER during the life of the Contract to control erosion and water pollution, through the use of berms, sediment basins, fiber mats, netting, mulches, grasses, slope drains, temporary silt fences, and other control devices.
- B. The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features, to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.
- C. The City of Chattanooga, Department of Public Works, Storm Management Division guidelines, "General Criteria for Controlling Erosion and Sediment from Land Disturbing Activities." 1988 edition shall be included in these specifications by references.

PART 2 - PRODUCTS

2.01 SEDIMENT STRUCTURES

Sediment basins, ponds, and traps, are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from siltation.

2.02 TEMPORARY SEEDING AND MULCHING

Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. All cut and fill slopes including waste sites and borrow pits shall be seeded when and where necessary to eliminate erosion. See Section 02485.

2.03 BALED HAY OR STRAW CHECKS

- A. Baled hay or straw erosion checks are temporary measure to control erosion and prevent siltation. Bales shall be either hay or straw containing five (5) cubic feet or more of material.
- B. Baled hay or straw checks shall be used where the existing ground slopes toward or away from the embankment, along the toe of slopes, in ditches, or other areas where siltation erosion or water run-off is a problem.

2.04 TEMPORARY SILT FENCES

Silt fences are temporary measure utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the run-off water.

2.05 EROSION CONTROL FABRIC

Erosion control fabric shall be Hold/Gro Erosion Control Fabric as manufactured by Gulf States Paper Corporation, or approved equal, and shall consist of strips of biodegradable paper, interwoven with yarn that is subject to degradation by ultraviolet light.

PART 3 - EXECUTION

3.01 PROJECT REVIEW

Prior to the preconstruction conference, the Contractor shall meet with the ENGINEER and go over in detail the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined. It is the basic responsibility of the Contractor to develop an erosion control plan acceptable to the ENGINEER.

3.02 PRECONSTRUCTION CONFERENCE

At the preconstruction conference, the Contractor shall submit for acceptance his schedule for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, bridges and other structures at watercourses, construction, and paving. He shall also submit for acceptance his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the ENGINEER.

3.03 CONSTRUCTION REQUIREMENTS

- A. The ENGINEER has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, and borrow and fill operations, and the authority to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of sediment basins, and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the ENGINEER.
- B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures shall be used to correct conditions

that develop during construction that were not foreseen during the design stage that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

- C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing, exceed 15,000 square feet without approval by the ENGINEER.
- D. The ENGINEER will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- E. Under no conditions shall the amount of surface area or erodible earth material exposed at one time by excavation or fill within the project area exceed 15,000 square feet without prior approval by the ENGINEER.
- F. The ENGINEER may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.
- G. In the event of conflict between these requirements and Federal or State or local agencies, the more restrictive laws, rules, or regulations shall apply.

3.04 CONSTRUCTION OF STRUCTURES

A. SEDIMENT STRUCTURES

1. Sediment structures shall be utilized to control sediment at the foot of embankments where slope drains outlet; at the bottom as well as in the ditch lines atop waste sites; in the ditch lines or borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least twice as long as they are wide.
2. When use of temporary sediment structures are to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

B. TEMPORARY SEEDING AND MULCHING

Seeding and mulching shall be performed in accordance with the section entitled "Seeding and Mulching."

C. BALED HAY OR STRAW EROSION CHECKS

Hay or straw erosion checks shall be embedded in the ground 4 to 6 inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the ENGINEER. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.

D. TEMPORARY SILT FENCES

1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or other areas where siltation is a problem. Silt fences are constructed of wire mesh with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil.
2. The Contractor shall be required to maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the ENGINEER. The silt fence becomes the property of the Contractor whenever the fence is removed.

E. EROSION CONTROL FABRIC

1. Fabric shall be installed immediately after seeding operations have been completed in work areas. Mulch shall not be used under the fabric.
2. Installation instructions shall be supplied by the manufacturer, and fabric shall be applied in accordance with the manufacturer's recommendation as directed by the specifier.
3. Fabric shall be unrolled and draped loosely, without stretching, so that continuous ground contact is maintained. In ditches, fabric shall be unrolled and applied parallel to the flow direction. On slopes, fabric shall be applied parallel to the slope direction unless the ENGINEER approves an alternate application method.
4. In ditches and on slopes, each upslope and each downslope end of each piece of fabric shall be placed in a 4-inch trench, stapled on 9-inch centers, backfilled and tamped. Where one roll ends and a second roll starts, the upslope piece shall be brought over the end of the downslope roll so that there is a 12-inch overlap, placed in a 4-inch trench, stapled on 9-inch centers, backfilled and tamped.

5. On slopes where two or more widths of fabric are applied, the two edges shall be overlapped according to manufacturer's installation instructions and stapled at 18-inch to 24-inch intervals along the exposed edge of the lap joint. The body of the fabric shall be stapled in a grid pattern with staples 3 feet maximum on center each way.
6. Where heavy concentrations of water or extremely erodible soil conditions exist, erosion checks shall be installed at intervals up to 50 feet as directed by the ENGINEER. Erosion checks shall be a 4-inch deep trench perpendicular to the flow line across the width of the fabric. The fabric shall be stapled at 9-inch intervals along the bottom of the trench across the entire width of the fabric, backfilled and stamped.

3.05 MAINTENANCE

- A. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.
- B. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of work as scheduled, and are ordered by the ENGINEER, such work shall be performed by the Contractor at his own expense.
- C. Where the work to be performed is not attributed to the Contractor's negligence, carelessness, or failure to install permanent controls and falls within the specifications for a work item that has a contract price, the units of work shall be paid for at the proper contract prices.

3.06 EROSION CONTROL OUTSIDE PROJECT AREA

Temporary pollution control shall not include construction work outside the project area where such work is necessary as a result of construction such as: borrow pit operations, haul roads and equipment storage sites. Bid Price in such cases shall not include all necessary clearing and grubbing, construction incidentals, maintenance, and site restoration when no longer needed. This will be the responsibility of the Contractor.

END OF DOCUMENT

**SECTION 02485
SEEDING AND MULCHING**

PART 1 - GENERAL

1.01 SCOPE

- A. The Work covered by this Section consists of furnishing all labor, equipment, and material required to place topsoil, seed, commercial fertilizer, agricultural limestone, and mulch material, including seedbed preparation, harrowing, compacting, and other placement operations on graded earthen areas as described herein and/or shown on the Drawings. In general, seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement, or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.

- B. The Work shall include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion.

1.02 QUALITY ASSURANCE

- A. Prior to seeding operations, the CONTRACTOR shall furnish to the ENGINEER labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the CONTRACTOR of any responsibility or liability for furnishing seed meeting the requirements of this section.

- B. Prior to topsoil operations, the Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Service or other certified testing laboratory.

- C. All existing lawns encountered shall be replaced with topsoil and seeding of the same type and quality as that existing prior to construction and shall be restored to original condition or better.

PART 2 - PRODUCTS

2.01 TOPSOIL

- A. The CONTRACTOR shall place a minimum of 4 inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the ENGINEER prior to disturbance.

- B. Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2 inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips, or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and perennial weed seeds, and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.
- C. Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam, or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, of organic matter as determined by loss on ignition of oven-dried samples to 65 degrees C. The ignition test shall be performed on samples which have been thoroughly oven-dried to constant weight at a temperature of 221 degrees F.

2.02 SEED

- A. Seed shall be delivered in new bags or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.
- B. All seed shall be from the last crop available at time of purchase and shall not be moldy, wet, or otherwise damaged in transit or storage.
- C. Seed shall bear the growers analysis testing to 98% for purity and 90% for germination. At the discretion of the ENGINEER, samples of seed may be taken for check against the growers analysis.
- D. Species, rate of seeding, fertilization, and other requirements are shown in the Seeding Requirements Table.

2.03 FERTILIZER AND LIMING MATERIALS

- A. Fertilizer and liming materials shall comply with applicable state, local, and federal laws concerned with their production and use.
- B. Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in the Seeding Requirements Table. Container bags shall have the name and address of the manufacturer, the brand name, net weight, and chemical composition.

PERMANENT SEEDING REQUIREMENTS TABLE					
			Rates per 1,000 Square Feet		
Area	Sowing Season	Species	Seed	Fertilizer	Limestone
Flat to rolling terrain with slopes less than 3:1	3/1 to 6/1	Kentucky 31 Fescue Ladino White Clover*	4 lbs. 1/4 lb.	30 lbs. 6-12-12	100 lbs.
	8/1 to 11/1	Kentucky 31 Fescue Ladino White Clover* Annual Ryegrass	4 lbs. 1/4 lb. 2 lbs.	30 lbs. 6-12-12	100 lbs.
Embankments with slopes greater than 3:1	3/1 to 6/1	Hulled Sericea Lespedeza* Kentucky 31 Fescue Weeping Lovegrass	1 lb. 3 lbs. 1/4 lb.	30 lbs. 6-12-12	100 lbs.
	8/1 to 11/1	Unhulled Sericea Lespedeza* Kentucky 31 Fescue Annual Ryegrass	1 lb. 3 lbs. 2 lbs.	30 lbs. 6-12-12	100 lbs.
*Requires inoculation.					

- C. Agricultural limestone shall be a pulverized limestone having a calcium carbonate content on not less than 85% by weight. Agricultural limestone shall be crushed so that at least 85% of the material will pass a No. 10 mesh screen and 50% will pass a No. 40 mesh screen.

2.04 MULCH MATERIAL

- A. All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.
- B. Mulch shall be composed of wood cellulose fiber, straw, or stalks, as specified herein. Mulch shall be suitable for spreading with standard mulch blowing equipment.
- C. Wood-cellulose fiber mulch shall be as manufactured by Weyer-Hauser Company, Conway Corporation, or equal.
- D. Straw mulch shall be partially decomposed stalks of wheat, rye, oats, or other approved grain crops.
- E. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum, or other approved standing field crops.

2.05 MULCH BINDER

- A. Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non-toxic to plant life and shall be acceptable to the ENGINEER.
- B. Emulsified asphalt binder shall be Grade SS-1, ASTM D 977. Cut-back asphalt binder shall be Grade RC 70 or RC 250.

2.06 INNOCULANTS FOR LEGUMES

All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen-fixing bacteria that is adapted to the particular seed involved.

2.07 WATER

Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the CONTRACTOR.

PART 3 - EXECUTION

3.01 SECURING AND PLACING TOPSOIL

- A. Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the ENGINEER.
- B. The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage, and other characteristics as to offer assurance that, when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.
- C. All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen, or its residue, and any other refuse which will hinder or prevent growth.
- D. In securing topsoil from a designated pit or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil, or if required by the ENGINEER, the pit shall be abandoned.
- E. Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the ENGINEER.

3.02 SEEDBED PREPARATION

- A. Before fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line free from unsightly variation, bumps, ridges and depressions, and all detrimental materials, roots, and stones larger than 1 inch in any dimension shall be removed from the soil.
- B. Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2 inches with a weighted disc, tiller, pulvimixer, or other equipment, until the surface is smooth and in a condition acceptable to the ENGINEER.
- C. If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be placed in a condition suitable for seeding.

- D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition.

3.03 FERTILIZATION AND LIMING

- A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in the Seeding Requirements Table. Copies of all weight tickets shall be furnished to the ENGINEER.
- B. Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of 1/2 inch.
- C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. The seed shall not remain in water containing fertilizer for more than 30 minutes when a hydraulic seeder is used.
- D. Agricultural limestone shall be thoroughly mixed into the soil according to the rates in the Seeding Requirements Table. The specified rate of application of limestone may be reduced by the ENGINEER if pH tests indicate this to be desirable. It is the responsibility of the CONTRACTOR to obtain such tests and submit the results to the ENGINEER for adjustment in rates.
- E. It is the responsibility of the Contractor to make one application of maintenance fertilizer according to the recommendations listed in the Seeding Requirements Table.

3.04 SEEDING

- A. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in the Seeding Requirements Table unless otherwise approved by the ENGINEER. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation. Copies of all weight tickets shall be furnished to the ENGINEER.
- B. Seeds shall be uniformly sown by any approved mechanical method to suite the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder, or approved mechanical power drawn seed drills. Hydro-seeding and hydro-mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seedings at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.
- C. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8 inch by a cultipacker or suitable roller.

- D. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculated in accordance with the manufacturer's mixing instructions.

3.05 MULCHING

- A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion, and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.
- B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:
 - 1. Wood Cellulose Fiber 1,400 lbs./acre
 - 2. Straw 4,000 lbs./acre
 - 3. Stalks 4,000 lbs./acre

These rates may be adjusted at the discretion of the ENGINEER at no additional cost to the OWNER, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

- C. Mulch on slopes greater than 3 to 1 ratio shall be held in place by the use of an approved mulch binder. Binder shall be thoroughly mixed and applied with the mulch. Emulsified asphalt or cutback asphalt shall be applied at the approximate rate of 5 gallons per 1,000 square feet as required to hold the mulch in place.
- D. The CONTRACTOR shall cover structures, poles, fence, and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.
- E. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates.

3.06 WATERING

- A. CONTRACTOR shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain an adequate water content in the soil.
- B. Watering shall be accomplished by hoses, tank trucks, sprinklers in such a way to prevent erosion, excessive runoff, and overwatered spots.

3.07 MAINTENANCE

- A. Upon completion of seeding operations, the CONTRACTOR shall clear the area of all equipment, debris, and excess material and the premises shall be left in a neat and orderly condition.

- B. The CONTRACTOR shall maintain all seeded areas without additional payment until final acceptance of the work by the Owner. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gullies, washouts, or other causes shall be repaired by filling with topsoil, compacting, and repeating the seeding work at contractor's expense.

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**SECTION 02560
MANHOLES**

PART 1 - GENERAL

1.01 SCOPE

The work covered by this Section includes furnishing all labor, equipment and materials required to install cast-in-place, and/or precast concrete manholes, and concrete junction chambers as described herein and/or shown on the Drawings.

1.02 DESIGN CRITERIA

- A. Manholes shall be constructed of specified materials to the sizes, shapes, and dimensions and at the locations shown on the Drawings or as otherwise directed by the ENGINEER. The height or depth of the manhole will vary with the location, but unless shown otherwise on the Drawings shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface and the invert will be at the designed elevations.
- B. Where the difference in the invert elevation of a sewer 18 inches in diameter or smaller and any other sewer intersecting in one manhole is 18 inches or more, a dropmanhole shall be constructed as shown on the Drawings. They shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed outside the manhole and be supported by Class B Concrete.

1.03 QUALITY ASSURANCE

- A. Prior to delivery all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory or, if approved by the ENGINEER, certified copies of test reports prepared by the manufacturer's testing laboratory will be acceptable. All materials which fail to conform to these specifications shall be rejected.
- B. After delivery to the site, any materials which have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site.

1.04 SHOP DRAWINGS AND ENGINEERING DATA

Complete shop drawings and engineering data on frames, covers, steps, and precast manhole sections shall be submitted to the ENGINEER in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.05 GUARANTEE

Provide a guarantee against defective materials and workmanship in accordance with the requirements of the Section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 CONCRETE AND REINFORCEMENT

- A. Concrete used in manhole and junction chamber construction shall be Class A concrete conforming to the requirements of the Section entitled "Cast-In-Place Concrete" of these Specifications.
- B. Steel reinforcement shall conform to the requirements of the Section entitled "Cast-In-Place Concrete Reinforcement" of these Specifications.

2.02 MORTAR

- A. Mortar for manhole construction shall be sand cement mortar composed of one part Portland Cement to two parts clean sand conforming to ASTM C 144. Twenty pounds of hydrated lime per sack of cement may be added. No retempered mortar shall be used.
- B. Non-shrink mortar shall be pre-mixed, Master Builders "Masterflow 713", Sonneborn "Ferrolith G-D.S. Redi-Mixed", or equal.

2.03 PRECAST CONCRETE MANHOLES

- A. Precast concrete manholes shall consist of precast reinforced concrete sections, a conical or flat slab top section, and a base section conforming with the typical manhole details as shown on the Drawings.
- B. Precast manhole sections shall be manufactured, tested, and marked in accordance with the latest provision of ASTM C 478.
- C. The minimum compressive strength of the concrete for all sections shall be 4,000 psi.
- D. The maximum allowable absorption of the concrete shall not exceed eight (8%) percent of the dry weight.
- E. The circumferential reinforcement in the riser sections, conical top sections, and base wall sections shall consist of one line of steel and shall be not less than 0.12 square inches per lineal foot.
- F. The ends of each reinforced concrete manhole riser section and the bottom end of the manhole top section shall be so formed that when the manhole risers and the top are assembled, they will make a continuous and uniform manhole.

- G. Joints of the manhole sections shall be tongue and groove. Sections shall be joined using either an O-ring gasket or a mastic sealant consisting of bitumen and inert mineral fibers. The sealant shall be applied in accordance with the manhole manufacturer's requirements. A sufficient amount of sealant should be used to fill the annular joint space with some squeeze out.
- H. Each section of the precast manhole shall have not more than two (2) holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.
- I. Cast iron or reinforced plastic manhole steps shall be installed in each section of the manhole in accordance with the details on the Drawings.

2.04 FRAMES, COVERS, AND STEPS

- A. Cast iron manhole steps, toe pockets, frames, and covers shall be cast iron conforming to the minimum requirements of Federal Specifications WW-1-652 or to ASTM A 48, "Gray Iron Castings," for Class 35B. All castings shall be made accurately to the required dimensions, fully interchangeable, sound, smooth, clean, and free from blisters and/or other defects. All regular manhole frames and covers shall be the City's Standard as manufactured by Acheson Foundry A2024-81C weight of 350 pounds as shown on the drawings.

Defective castings which have been plugged or otherwise treated shall not be used. All castings shall be thoroughly cleaned and painted or coated with a bituminous paint.

- B. Reinforced plastic manhole steps shall conform to the minimum requirements of ASTM 2146-68 under Type II, Grade 16906 and ASTM C-478, Paragraph 11. The reinforcing bar shall be a Grade 60, deformed 1/2-inch reinforcing bar conforming to all the requirements of ASTM A-615.
- C. All manhole frames and covers shall be of the size and weight shown on the Drawings. All regular manhole frames and covers shall be the City's Standard as manufactured by Acheson Foundry A2024-81C weight of 350 pounds as shown on the drawings.
- D. Watertight manhole covers shall be furnished with a rubber gasket, stainless steel tightening bolt, machined bearing surfaces, channel iron locking bar, and concealed watertight pick hole, and shall weigh not less than 590 pounds, and shall be of the size and dimensions shown on the Drawings. Watertight manhole covers shall be equivalent to A2624-71C as manufactured by Acheson Foundry of Chattanooga, Tennessee.

- E. The contact surfaces of all manhole covers and the corresponding supporting rings in the frames shall be machined to provide full perimeter contact.
- F. All sanitary sewer manhole covers shall have the words "CITY OF CHATTANOOGA" and "SEWER" as designated by the Engineer cast on the top in letters two (2) inches high or other as directed.
- G. An adjusting ring equal to R1979 as manufactured by Neenah Foundry Company of Neenah, Wisconsin, shall be provided for each manhole in a street. Adjusting rings shall provide a minimum inside clear opening of 24 inches and shall be made to be capable of being bolted to the manhole frame.

PART 3 - EXECUTION

3.01 GENERAL MANHOLE CONSTRUCTION

- A. All manhole bases, including curved manhole bases, and inverts shall be constructed of Class A concrete in accordance with details on the Drawings and inverts shall be smooth and accurately shaped and have the same cross section as the invert of the sewers which they connect.

The manhole base and invert shall be carefully formed to the required size and grade by gradual and even changes in sections, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations. Changes in direction of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit.

- B. Pipe of all diameters shall be connected to manholes using an integrally cast A-lock elastomeric ring, a Kor-N-Seal rubber boot, or approved equal flexible connector and shall be installed as recommended by the manufacturer. Connections using mortar or other rigid materials will not be acceptable. Connections to existing manholes shall be cored. "Hammer taps" will not be acceptable.
- C. The manhole steps shall be inserted into the wall of the manhole at the proper locations and elevations and shall be securely embedded in the wall.
- D. Any adjustment necessary for manhole frame elevation shall be made with concrete "donut" sections. A maximum of three (3) sections shall be permitted.
- E. The cast iron frame for the manhole cover shall be set at the required elevation and properly anchored to the masonry. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted to conform to the exact slope, crown, and grade of the existing adjacent pavement.

- F. Masonry work shall be allowed to set for a period of not less than 24 hours. Outside forms, if any, shall then be removed and the manhole backfilled and compacted in the manner provided in the Section entitled "Earthwork" of these Specifications. All loose or waste material shall be removed from the interior of the manhole. The manhole cover then shall be placed and the surface in the vicinity of the work cleaned off and left in a neat and orderly condition.
- G. After backfilling has been completed, the excavated area if located in a street, alley, or sidewalk, shall be provided with a temporary surface, as directed by the ENGINEER.

3.02 CONSTRUCTION OF CAST-IN-PLACE CONCRETE MANHOLES

- A. Cast-in-place manholes, excluding curved manhole bases, shall be constructed in place with the base, barrel and conical section all monolithically cast using removable forms of a material and design approved by the ENGINEER
- B. The vertical forms, vertical and horizontal wall spacers steps and placing cone must be carefully positioned and firmly clamped in place before any placement is made. The wall spacers must be located 90 degrees from each other. The forms shall be firmly supported with bottom of forms at the proper elevation to permit the base to be deposited through the vertical forms.
- C. The manhole base shall be deposited down through the wall forms onto undisturbed earth or rock bearing. It shall be evenly distributed around the wall and vibrated both inside and outside the forms until there is a minimum slope of 60 degrees from the bottom of the forms to the bearing surface both inside and outside of the manhole. When this is complete and before additional concrete is added, the concrete must be carefully vibrated on each side of each sewer pipe.
- D. The base shall be concentric with the manhole and have a minimum diameter of 16 inches greater than the outside diameter of the manhole, and 10-inch minimum thickness under the lowest pipe. Minimum wall thickness shall be six (6) inches.
- E. Additional concrete must be deposited in evenly distributed layers of approximately 18 inches with each layer vibrated to bond it to the preceding layer. The wall spacers must be raised as the placements are made. The concrete in the area from which the spacer is withdrawn shall be carefully vibrated. Excessive vibration shall be avoided.
- F. Adjustment rings shall be provided between the conical section and the manhole frame. The rings shall be cast-in-place using building felt between pours to create a weakened joint or as directed by the ENGINEER. If adjustment of the lid elevation is called for, concrete "donut" sections shall be used.

- G. The invert and flow channel shall be constructed in accordance with the applicable requirements of Part 3.01 of this Section and shall be formed during or immediately after the placing of the concrete and brush-finished as soon as the concrete has sufficiently set.
- H. Form marks and offsets shall not exceed one (1) inch on the outside surface of the manhole. Form marks and offsets shall not exceed 1/2 inch inside of the manhole. All offsets on the inside surface of the manhole shall be smoothed and rubbed so there is no projection or irregularity capable of scratching a worker or catching and holding water or solid materials. Honeycombed areas shall be completely removed immediately upon removal of the forms and replaced with Class A concrete.
- I. Should circumstances make a cold joint necessary, a formed groove or reinforcing dowels shall be required in the top of the first placement for shear protection. Immediately before the second placement is made, the surface of the cold joint shall be thoroughly cleaned and wetted with a layer of mortar being deposited on the surface.
- J. Concrete setting time, backfilling, masonry work, setting frame and cover, temporary paving, etc., shall be in accordance with the applicable requirement of Part 3.01 of this Section.

3.03 CONSTRUCTION OF PRECAST CONCRETE MANHOLES

- A. The base and invert shall be constructed in accordance with the applicable requirements of Part 3.01 of this Section.
- B. After the base section has been allowed to set for a period of not less than 24 hours, the precast manhole sections shall be placed thereon, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations.
- C. Manhole sections shall be set so that the manhole steps align vertically.
- D. Masonry work required to complete the precast concrete manhole shall be done in accordance with the provisions of Part 3.01 of this Section.
- E. Fill all joints, lifting holes, and other imperfections inside and outside with non-shrink mortar, overlapping the seam 2" on both sides, to form a neat, smooth finish. Manholes shall be completely waterproof.
- F. Concrete setting time, backfilling, setting frame and cover, temporary paving, etc., shall be in accordance with the applicable requirements of Part 3.01 of this section.

3.04 CONSTRUCTION OF PRECAST CONCRETE "TEE" MANHOLE BASES

- A. Precast concrete tee manhole bases and elbows shall conform to the requirements of the Section entitled "Concrete Pipe Sewers" of these Specifications. Class of pipe used shall be the same as that used in the line adjacent to the manhole and elbow. The tee section shall be carefully formed to the required size. The inside of the base shall be left smooth with no rough edges or protrusions.
- B. Elbows where required shall be fabricated to a true angle as shown on the drawings. Elbows shall be made smooth by hand troweling and the finished surface shall be equal to that in the rest of the pipe.
- C. All fabrication work on the manhole base and elbows shall be done by the manhole or pipe manufacturer at the plant. No field fabrication will be permitted without specific authorization of the ENGINEER.
- D. After the base section has been installed, the precast manhole sections shall be placed thereon.
- E. Masonry work required to complete the precast concrete manhole shall be done in accordance with the provisions in Part 3.01 of this Section.
- F. Concrete setting time, backfill, masonry work, setting frame and cover, temporary paving, etc., shall be in accordance with the applicable requirements of Part 3.01 of this Section.

3.05 CONSTRUCTION OF JUNCTION CHAMBERS

- A. Junction chamber toe pockets shall conform to the applicable requirements of Part 2.04 of this section and shall be placed as shown on the Drawings.
- B. The concrete shall be constructed in strict accordance with the Drawings and other applicable specifications and all lines inside the chamber shall be finished smooth with no protrusions to obstruct flow, all subject to the approval of the ENGINEER.
- C. During construction of the junction chambers, the existing sewage flow shall be maintained in a manner acceptable to the ENGINEER. Bypassing of sewage into streams or storm water drainage facilities will not be permitted. If the junction chamber is to be built on an existing sewer, the section of sewer within the junction chamber shall be removed before the base of the junction chamber is poured unless shown otherwise on the Drawings.
- D. All ground areas that are disturbed during construction of the junction chamber shall be prepared and grassed as called for elsewhere in these Specifications.

3.07 TESTING

Manholes installed in this contract shall be tested prior to backfilling for compliance with the infiltration limits specified for pipe used in this contract. The method shall be a vacuum test in which manholes are plugged, pumped to 5 psi vacuum, and held for a minimum of one (1) minute. The manhole shall be approved when it loses less than one (1) psi vacuum pressure during the 1 minute test period.

END OF SECTION

SECTION 02607
NEW AND REPLACEMENT PAVING AND SIDEWALKS

PART 1 - GENERAL

1.01 SCOPE

The work to be performed under this section shall include replacing existing sidewalks and pavement in paved streets, driveways, and parking areas where such sidewalks and pavement have been removed for constructing water pipelines, fire hydrants, sewers, manholes, and all other water and sewer appurtenances and structures. It shall also include temporary paving, and new sidewalks and pavements where applicable.

PART 2 - PRODUCTS

2.01 TYPES OF PAVEMENT

- A. All existing pavement in streets, driveways, or parking areas which is removed, destroyed, or damaged by construction of sewage or water works shall be replaced as specified below, as shown on the Drawings, or as called for in the Bid Schedule. Unless otherwise shown or specified, all paved surfaces shall be replaced using the applicable pavement replacement Type 1 thru 5 as shown on the Drawings. Pavement shown or specified to be replaced for the full width of the street shall be types 6, 7 or 8 as applicable and as shown on the Drawings. Materials, equipment, and construction methods used for paving work shall conform to the Specifications applicable to the particular type required for replacement, repair, or new pavements.
1. Type 1 portland cement concrete pavement shall be Class "A" concrete conforming to the section entitled "Cast-In-Place Concrete" of these Specifications, having minimum compressive strength of 3500 psi. The surface shall conform to the grade and elevation of the surrounding pavement. The slab shall be of a depth of eight (8) inches as shown on the drawings.
 2. Type 2 - not used.
 3. Type 3 asphaltic concrete pavement for heavy-duty use shall have a maximum thickness of three (3") inches placed in two equal layers. Type 3 pavement shall be composed of plant mix, asphaltic concrete Grading E conforming to "Asphaltic Concrete Surface (Hot Mix)," Section 411, Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition. The pavement mixture shall not be spread until the designated surface has been previously cleaned and prepared, is intact, firm, properly cured, dry, and the tack coat has been applied.

4. Type 4 - not used.
 5. Type 5 bituminous penetration pavement shall conform to Section 404, "Double Bituminous Surface Treatment," Tennessee Department of Transportation, Standard Specification for Road and Bridge Construction, latest edition.
 6. Replacement of portland cement concrete driveways shall be Class "A" concrete conforming to the section entitled "Cast-In-Place Concrete" of these Specifications. The surface finish of the concrete pavement shall conform to that of the existing pavement. The slab shall be of depth equivalent to the existing concrete pavement, but in no case less than six (6) inches thick. Expansion joints removed shall be replaced.
 7. Replacement of portland cement concrete sidewalks shall be Class "A" concrete conforming to the section entitled "Cast-In-Place Concrete" of these Specifications. The surface finish of the concrete sidewalk shall conform to that of the existing sidewalk. The slab shall be of depth equivalent to the existing concrete sidewalk but in no case less than four (4) inches thick. Expansion joints removed shall be replaced.
 8. Where sewerage or water lines and appurtenances are constructed in or across unpaved, chert, or crushed stone surfaced streets, roadways, driveways, or parking areas, the surface removed or damaged shall be repaired or replaced with a minimum of six (6) inches of crushed stone in accordance with Section 401, "Mineral Aggregate Surface," of the Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.
 9. Unless permanent replacement can be made on the same day as the removal of the surface, and traffic is to be reinstated, temporary pavement repairs shall be made with two inches (2") of cold mix or hot bituminous seal coat. Permanent repair **MUST** be made within ten (10) working days from date of pavement cut.
- B. In no case shall paving repair be commenced without prior approval of the Engineer of the type pavement, the equipment to be used, and the method or procedure to be used.

PART 3 - EXECUTION

3.01 REPLACING PAVEMENT

- A. Pavements removed or damaged shall be replaced in accordance with the following procedures:
1. The existing street pavement or surface shall be removed along the line of the work for the allowable width specified for the trench or structure. All edges of the existing pavement shall be cut to a straight, vertical edge and care shall be used to get a smooth joint between the old and new pavement and to produce an even surface on the completed street. Cement concrete slabs, cement concrete base slabs and crushed stone bases, if required, shall be placed and the concrete allowed to cure for three (3) days before asphaltic concrete surface courses are applied. Expansion joints where applicable shall be replaced in a manner equal to the original joint.
 2. After the installation of the sewer or water lines, the trench shall be backfilled with thoroughly compacted crushed stone from the top of bedding to finished grade unless otherwise specified on the Drawings. Backfill shall be placed as specified in the section entitled "Earthwork," Paragraph 2.05, of these Specifications.
 3. Trench backfill along streets shall be covered with permanent paving or with a temporary paving as specified above. The temporary paving shall be applied level with the existing paved surface at a time directed by the engineer. Prior to the application of the temporary paving the crushed stone backfill shall be maintained carefully at grade and dust free. Additionally, immediately prior to application of permanent paving by Contractor or acceptance by the City, Contractor shall again compact the top of all trench backfill in the streets with a hydrotamper and add sufficient crushed stone to bring surface back to bottom of permanent paving as shown on Drawings.
 4. Unless otherwise shown or specified, all paved surfaces shall be replaced with pavement of like kind as specified in Paragraph 2.01. The pavement shall be either specified trench width or the full width of the street as shown in the Bid Schedule.
 5. Where pavement is specified for trench width only, the temporary surface or sub-base for permanent paving shall be compacted and finished to the base grade compatible with the type of pavement to be applied before pavement is placed. Additional width of pavement to be removed, if any, as shown on the drawings shall be done immediately prior to replacing the pavement. Any additional pavement or street surface removed or damaged beyond the limits shown on the Drawings shall be replaced or repaired by the Contractor at the Contractor's expense.

6. Where the pavement is for the complete width of the street, the following procedures shall be used;
 - a. After the crushed stone backfill and temporary surface have settled thoroughly, the entire width of the street to be paved shall be cleaned of loose materials as specified in Section 407, "Bituminous Plant Mix Pavements," Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition. All areas which have settled shall be filled and leveled as described above in Paragraph 3. Manholes shall be raised to match finished grade using precast concrete rings. Before paving a tack coat shall be applied to the full width of the street, as specified in Section 403 "Tack Coat," Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.
 - b. During the time that the full width of the street is being paved, the Contractor shall extend the paving from the street into existing paved driveways in order to provide a smooth transition from the street to the existing driveway grade. This work shall be completed to the satisfaction of the Engineer with no separate payment being allowed.
7. Wherever sewer or water lines are constructed across state highways, the Contractor shall comply with all requirements and provisions of the Standard Method of the Tennessee Department of Transportation for opening trenches through highways and replacing pavements as shown on the Drawings and specified herein. All such work shall be subject to inspection and approval by the Tennessee Department of Transportation.
8. Contractor shall remove all surplus excavation materials and debris from the street surfaces and rights-of-way and shall restore street, roadway or sidewalk surfacing to its original condition. This work shall be considered as cleanup and no separate payment will be made for this item.

302. NEW PAVEMENTS

- A. Access roads, parking areas, and other roadways shall be surfaced as shown on the Contract Drawings. The material shall be placed sufficiently thick to produce, after compaction, a uniform surface with a minimum thickness as shown on the drawings and shall be shaped to the required line and grade. Materials, equipment and construction methods used for paving work shall conform to the Specifications for the particular surface required.
- B. Bituminous penetration pavement, Portland Cement Concrete base course or pavement and bituminous concrete pavement shall include a base course constructed in accordance with the requirements of Section 303, "Mineral Aggregate Base," Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition. The completed

crushed stone road base shall be maintained by the Contractor in a smooth, first-class condition to required line, grade and cross section until the entire surface area has become stabilized and compacted. Roadway materials shall not be placed on soft, wet or frozen sub-grade.

- C. After the base has become stabilized, the entire surface shall be covered with the surface course called for on the Drawings. The surface course shall not be placed until all other items of work are completed.
- D. Portland Cement Concrete base course or pavement shall be placed as herein specified in this Section. Asphaltic concrete pavement shall be placed as herein specified in Paragraph 2.01. Bituminous penetration surface shall be constructed in accordance with Section 404, "Double Bituminous Surface Treatment," Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.
- E. Crushed stone surface shall be placed as herein specified in this section, Paragraph 2.01.

3.03 MAINTENANCE

The Contractor shall maintain the surfaces of roadways built and pavements replaced until the acceptance of the project. Maintenance shall include such dragging, reshaping, refilling, wetting, rerolling, and reapplication of the temporary paving surface as are necessary to prevent raveling of the road material, the preservation of reasonably smooth surface and repair of damaged or unsatisfactory surfaces to the satisfaction of the Engineer. Maintenance shall also include sprinkling as may be necessary to abate dust.

3.04 SIDEWALK REPLACEMENT

A. MATERIALS

1. All concrete sidewalks shall be built and/or replaced with Class "A" concrete which shall conform with requirements of the section entitled "Cast-in-Place Concrete" of these Specifications.
2. Preformed joints shall be 1/2-inch thick conforming to the latest edition of AASHTO Standard Specifications, M59, for preformed bituminous fiber joints.
3. Concrete forms shall be of wood or metal, shall be straight and free from warp, and shall be of sufficient strength when in place to hold the concrete true to line and grade without springing or distortion.

- B. When a section of sidewalk is removed, the existing sidewalk shall be cut to a neat line perpendicular to both the centerline and the surface of the concrete slab. Existing concrete shall be cut along the nearest existing contraction joints unless such joints do not exist in which case the cut shall be made at minimum distances shown on the Drawings.
- C. Existing concrete sidewalks that have been cut and removed for construction purposes shall be replaced with sidewalks of the same width and surface as the portion removed and shall have a minimum uniform thickness of four (4") inches. The new work shall be neatly joined to the old concrete so that the surface of the new work shall form an even unbroken plane with the old sidewalk.
- D. The subgrade for concrete sidewalks shall be formed by excavating to a depth equal to the thickness of the concrete plus two (2) inches. Subgrade shall be of such width as to permit the proper installation and bracing of the forms. Subgrade shall be compacted by hand tamping, or rolling. Soft, yielding, or unstable material shall be removed and backfilled with satisfactory material. Two (2") inches of porous compacted crushed stone shall be placed and shall be compacted thoroughly and finished to a smooth, unyielding surface at proper line, grade, and cross section.
- E. Expansion joints shall be required to replace any existing expansion joints that are removed with the sidewalk or in new construction wherever shown on the Drawings. Expansion joints shall be true and even, shall present a satisfactory appearance, and shall extend to within one-half (1/2") inch of the top of finished concrete surface.
- F. Concrete shall be suitably protected from freezing and excessive heat. It shall be kept covered with burlap or other suitable material and kept wet until cured.

3.05 REPLACING CURBS

- A. All existing curbs which are removed, damaged, or destroyed during construction of sewerage or water works shall be replaced in accordance with the following:
 - 1. Asphaltic concrete curbs shall be constructed with the same dimensions as the existing curb using asphaltic concrete pavement Grading E, conforming to the section entitled "Asphaltic Concrete Pavement." Prior to constructing curbs on pavement, the pavement shall be dry and cleaned of loose material and a tack coat of RS-2 asphalt shall be applied to the curb area of the pavement at the rate of 0.08 to 0.20 gallons per 15 linear feet of curb area
 - 2. Portland Cement Concrete curbs shall be constructed with the same dimensions as the existing curb using Class A concrete in accordance with the sections entitled "Cast-In-Place Concrete" and with Section 702, "Cement Concrete Curb," Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.

**SECTION 02751
PREPARATORY CLEANING OF SEWERS**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the preparatory cleaning of designated sewer lines prior to the internal inspection of the sewer lines by closed-circuit television. The Contractor shall furnish all necessary material, labor, equipment and services required for cleaning the specific sewer lines authorized by the Engineer. Arrangements shall be made with the appropriate Water Company for the purchase of water at no additional cost to the owner.

1.02 GENERAL

- A. Sewer line walls shall be cleaned adequately to provide for a camera used in internal inspection to discern structural defect, misalignment, and infiltration/inflow sources. Cleaning immediately prior to internal inspection is required to preclude the build-up of debris from infiltration/inflow sources and upstream manhole sections.
- B. The term "clean" as used in these Specifications shall mean the adequate removal of sand, dirt, roots, grease and other solid or semisolid materials from the sewer lines. The designated sanitary sewer manhole sections shall be cleaned using mechanically powered, hydraulically propelled or high velocity sewer cleaning equipment, as specified.
- C. Hydraulic Cleaning Equipment:
 - 1. The equipment used shall be of a movable dam type and be constructed in such a way that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sewer. The movable dam shall be of equal diameter as the pipe being cleaned and shall provide a flexible scraper around the outer periphery to ensure total removal of grease. If sewer cleaning balls or other such equipment, which cannot be collapsed instantly, are used, special precautions against flooding of the sewers and public or private property, shall be taken.

D. High Velocity Hydro-Cleaning Equipment:

1. All high velocity sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two or more velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 degrees to 45 degrees in all size lines designated to be cleaned. Equipment shall also include a high velocity gun for washing and scouring manhole walls and floor. The gun shall be capable of producing flows from a fine spray to a long distance solid stream.

The equipment shall carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. All controls shall be located so the equipment can be operated above ground.

E. Mechanical Cleaning Equipment

1. Bucket machines shall be in pairs with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe will not be allowed. A power rodding machine shall be either a sectional or continuous type capable of holding a minimum of 750 feet of rod. The rod shall be specifically treated steel. To ensure safe operation, the machine shall have a fully enclosed body and an automatic safety throw-out clutch or relief valve.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. The equipment and methods selected shall be satisfactory to the Engineer's Representative. The equipment selected for cleaning shall be capable of removing dirt, grease, rocks, sand and other deleterious materials and obstructions from the sewer lines and manholes. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be re-setup on the other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or the equipment fails to traverse the entire manhole section, it will be assumed that a major blockage exists and the cleaning effort shall be abandoned. Blockages, if any, shall be reported to the Engineer immediately.

3.02 MATERIAL REMOVAL

A. All sludge, dirt, sand, rocks, grease and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from manhole section to manhole section which could cause line stoppages, accumulations of sand in wet wells, or damage to pumping equipment shall not be permitted.

3.03 DISPOSAL OF MATERIALS

A. All solids or semisolids resulting from the cleaning operations shall be removed from the site and disposed of in an approved manner. All materials shall be removed from the site no less than at the end of each workday. Under NO circumstances will the Contractor be allowed to accumulate debris, etc., on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Engineer.

3.04 CLEANING PRECAUTIONS

A. During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled cleaning tools, which depend upon water pressure to provide their cleaning force or any tools which retard the flow of water in the sewer line are used, precautions shall be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. The flow of sewage in the sewer lines shall be utilized to provide necessary pressures for hydraulic cleaning devices whenever possible. When additional quantities of water from fire hydrants are necessary to avoid delay in normal working procedures, the water shall be conserved and not used unnecessarily. No fire hydrant shall be obstructed in case of a fire in the area served by the hydrant nor shall a hydrant be used for the purpose described unless a vacuum break is provided.

3.05 FINAL ACCEPTANCE

A. Acceptance of this portion of the work shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Engineer's representative. In areas where cleaning was not found satisfactory during the television inspection, that section shall be cleaned again as designated by the Engineer.

3.06 RECORDING OF FIELD DATA

A. For each location where cleaning is performed, a cleaning report shall be completed which shall contain the following items of information.

1. Location, size, material, and condition of the reach.
2. Length of sewer cleaned.
3. Estimated amount and types of debris and sediment removed.
4. Grease build-ups.
5. Method required for cleaning.
6. Structural failure.

B. All preparatory cleaning shall be witnessed by the Engineer or his Project Representative to insure acceptability of work performance and record-keeping procedures of the Contractor. Preparatory cleaning records shall be ratified daily by the Engineer or his Representative.

END OF DOCUMENT

SECTION 02752
TELEVISION INSPECTION OF SEWERS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. This section shall apply to all extensions to the public sewer system and covers the internal inspection of all the sewers by a closed-circuit television camera to observe the conditions in the sewer lines. The Sewer Inspection Contractor shall furnish all necessary material, labor, equipment, and services required for the internal inspection of 100% of the sewer lines, including but not limited to, all recording and playback equipment, material, and supplies. Inspections shall be performed in the presence of the Engineer and/or Resident Project Representative (RPR).

1.02 RELATED WORK

- A. Preparatory Cleaning of Sewers as specified in Section 02751.
- B. Sewer Flow Control as specified in Section 02753.

1.03 GENERAL

- A. The Contractor shall determine by internal inspection the location, condition, and estimated flow rate for each source of infiltration and/or inflow within each sewer section. During the inspection, all the infiltration and/or inflow sources, structural defects, service connections, abnormal conditions, and other pertinent observations shall be recorded.
- B. All inspections will be witnessed by the Engineer or his Representative and performed one manhole section at a time. The flow in the section being inspected will be controlled, as specified in Section 02753.

1.04 EQUIPMENT

- A. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. The camera shall be of a 360-degree radial view design capable of operating in 100 percent humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing a minimum 700-line resolution video picture. Picture quality and definition shall be to the satisfaction of the Engineer's representative and if unsatisfactory, shall be re-televised at the contractor's expense.
- B. All videotapes used shall be either Sony or TDK Brand in VHS format.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PROCEDURE

- A. The camera shall be moved through the line in either direction at a uniform rate stopping when necessary to insure proper documentation of the sewer's condition but in no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interface with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation the television camera will not pass through the entire manhole section, the Contractor shall re-setup his equipment in a manner so that the inspection can be performed from the opposite manhole.
- B. Whenever non-remote powered and controlled winches are used to pull the television camera through the line, telephones, or other suitable means of communication shall be set up between the two manholes of the section being inspected to insure good communications between members.
- C. Movement of the television camera shall be temporarily halted at each visible point of interest (service line, defects, etc.) so that the radial view camera may better examine each object.

3.02 RECORDING OF FIELD OBSERVATIONS

- A. Television Inspection Logs:
 - 1. Information obtained shall be recorded on internal inspection logs with a format furnished or approved by the Engineer. The following information shall be recorded for each reach inspected:
 - a. Location and length of reach
 - b. Pipe size and material
 - c. Location and descriptions of service connections
 - d. Locations and descriptions of defects such as obstructions, intrusions, offset joints, hole, breaks, cracks, collapses, bends, or dips in alignment, protruding service connections, etc.
 - e. Items video-taped and/or photographed
- B. Photographs
 - 1. Instant developing, 35mm or other standard size photographs of the television monitor or problem areas shall be taken by the Contractor upon the request of the Engineer or his Representative to document unusual, questionable, or severe conditions found during the course of the work.

C. Video Tape Recording

1. The purpose of tape recording shall be to supply a visual and audio record of problem areas of the lines that may be replayed both daily and at future presentations by the Owner. All video tape recordings shall be made at standard speed (SP) for maximum clarity. Slow motion or stop motion play back features shall be supplied at the option of the Contractor. All video tapes and logs are considered property of the Owner and shall be submitted prior to release of retainage. The Owner may at their own expense perform selected or all warranty inspection prior to the end of the warranty period. The contractor shall be responsible for all the repairs necessary at that time.

- D. The Engineer or his Project Representative to insure acceptability of work and record-keeping procedures of the Contractor shall witness all television inspection. The Engineer or his Representative shall verify preparatory cleaning records.

END OF DOCUMENT

**SECTION 02753
SEWER FLOW CONTROL**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This covers the sewer flow control procedures of plugging, blocking, and by-pass pumping. The Contractor shall provide all material, equipment, labor and services necessary to perform the work in accordance with the items of this section.

1.02 RELATED WORK

- A. Preparatory cleaning of sewers as specified in Section 02751.
- B. Television Inspection as specified in Section 02752.

1.03 GENERAL

- A. When sewer line flows at the manhole section being replaced are sufficient to cause a washing of the bedding or backfill material into the line then the flows shall be reduced by one of the following methods: manual operation of pumping stations; plugging/blocking of the flows; or by pumping/bypassing of the flows, as specified by the Engineer or his Representative.
- B. Sewer flows shall not exceed five (5) percent of the pipe diameter for the respective line sizes as measured in the manhole when performing television inspection.
- C. Plugging, blocking, or bypassing of the sewer flow shall be considered incidental to the work and shall not be considered for payment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PLUGGING AND BLOCKING

- A. A sewer line plug shall be inserted into the line at a manhole upstream for the section being inspected. The plug shall be so designed that all or any portion of the sewage flows can be released. During the inspection portion of the operation, flows shall be shut off or reduced to within the maximum flow limits specified in 1.03 B. After the work tasks have been completed, flows shall be restored to normal.

3.02 PLUGGING AND BYPASSING

- A. When pumping/bypassing is required, the Contractor shall supply the necessary pumps, conduits and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flows plus additional flow that may occur during periods of a rain storm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. A "setup" consists of the necessary pumps, conduits, and other equipment to divert the flow of sewage around a manhole section, from the start to finish of work performed in the manhole section.

3.03 FLOW CONTROL PRECAUTIONS

- A. Whenever flows in a sewer line are blocked, plugged or bypassed, sufficient precautions must be taken to protect the sewer lines from damage that might be inflicted by excessive sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. Damage to said properties shall be the sole responsibility of the Contractor.

END OF DOCUMENT

SECTION 02930
RIPRAP

PART 1 – GENERAL

1.01 SCOPE

- A. The work covered by this section includes furnishing all labor materials, and equipment required to furnish, place, and set rock riprap, concrete block riprap, and sacked sand-cement riprap as shown on the Drawings and/or specified herein.
- B. Riprap shall be placed on slopes of embankments or other surfaces or around structures as protection against the erosive action of water.
- C. Where shown on the Drawings, a filter blanket course of crushed rock, or sand and gravel, or an approved filter fabric shall be placed under the riprap.

1.02 SUBMITTALS

- A. The CONTRACTOR shall provide the ENGINEER with written evidence in the form of mill test reports from a qualified testing laboratory that all sands, cements, and filter blanket materials used conform to the applicable requirements of this Specification section.
- B. When requested by the ENGINEER, the CONTRACTOR shall furnish representative samples of rock riprap material for classification, gradation, or other tests as the ENGINEER may direct.

PART 2 – PRODUCTS

2.01 ROCK RIPRAP

- A. Rock riprap shall be constructed using sound, dense, durable stones, or rock fragments, free from crack, pyrite intrusions and other structural defects. Stones which will be used with mortar shall be free from dirt, oil, or other material that might prevent good adhesion with the mortar. Stones with a laminated structure shall be avoided. Field stones shall not be used as a source of rock for riprap. Only rock that has been approved by the ENGINEER shall be used for riprap.
- B. When the crushed aggregate is subjected to five (5) alternations of the sodium Sulfate soundness test, the weighted percentage of loss shall be not more than 12 percent.
- C. Shape of the stones shall be generally rectangular or cubic. Flat or elongated stones having a small dimension less than 1/3 of the large dimension shall not be used.
- D. At least 50 percent of the stones or rock fragments for plain rock riprap shall Weigh 150 pounds or more. The sizes of the stones shall be well graded from the smaller to the larger.

- E. At least 90 percent of the stones or rock fragments for hand placed rock riprap shall weigh 100 pounds or more and shall be not less than 12 inches long, 12 inches deep, and 8 inches wide.

2.02 CONCRETE BLOCK RIPRAP

Concrete blocks for riprap shall be of the size as shown on the Drawings and shall be composed of non-reinforced Class A concrete conforming to the requirements of the section entitled "Cast-In-Place Concrete" of these Specifications..

2.03 SACKED SAND-CEMENT RIPRAP

- A. Sand-cement for sacked sand-cement riprap shall be composed of a dry mixture of one bag (94 pounds) of cement to 5 cubic feet of dry sand.
- B. Sacks shall be either cotton or jute, standard grade of cloth, which will hold the sand-cement mixture without leakage during handling and tamping. They shall be strong and shall be sized to hold approximately 1 cubic foot.
- C. Cement shall be Type I Portland Cement conforming to ASTM C 150.
- D. Sand shall be manufactured of natural siliceous river sand conforming to ASTM D 1073. The sand shall meet the following gradation requirements.

<u>Sieve Size</u>	<u>Total Percent Passing by Weight</u>
4	100
8	95-100
30	50-80
50	30-60
100	8-25
200	2-10

- D. Sand shall be clean, hard, and free from excessive organic matter.

2.04 GROUT

- A. Grout for grouted rock riprap shall be sand cement grout composed of one part Cement to four parts sand, measured by volume, mixed thoroughly with sufficient water to make a grout of such consistency that it will flow into and completely fill the voids.
- B. Cement shall be Type I Portland Cement conforming to ASTM C 150.
- C. Sand shall be cleaned, hard, natural siliceous sand conforming to the requirements of ASTM C 33 and the section entitled "Cast-In-Place Concrete" of these Specifications.
- D. Water shall be fresh, clean, portable water free from injurious amounts of oil, acid, alkali, or organic matter.

2.05 FILTER BLANKET MATERIAL

- A. Filter blanket material shall consist of fragments of sound, durable stone or crushed rock, free from disintegrated stone, alkali, salt, vegetable matter, or adherent coating. Aggregate shall be reasonably free from thin or elongated pieces. The percentage of wear of the aggregate as outlined AASHTO Test No. T-96 shall not exceed 7 percent.
- B. Aggregate shall have the following gradation:

<u>Sieve Size</u>	<u>Total Percent Passing by Weight</u>
1-1/4"	100
1"	95-100
3/4"	70-100
3/8"	50-85
No. 4	33-65
No. 10	20-45
No. 40	8-25
No. 200	0-10

- C. The material finer than the No. 10 sieve shall be of such characteristics and gradation that will prevent the mass from setting up or becoming cemented together. Stone or crushed rock meeting the requirements of the section entitled "Mineral Aggregate Base" of these Specifications may be used provided the percentage of aggregate passing the No. 100 sieve is less than 10 percent.

PART 3 – EXECUTION

3.01 EQUIPMENT

- A. All equipment necessary for the satisfactory performance of the work shall be on hand and approved by the ENGINEER before construction will be permitted to begin.
- B. The equipment shall include wooden or metal tamps of sufficient weight and number to properly compact the slopes on which the riprap or slope pavement is to be placed.
- C. Wooden hand tamps, having a tamping face not greater than 1 square foot, and of sufficient weight and number to properly tamp the riprap, shall be furnished when sacked sand-cement is used.
- D. Equipment for mixing cement grout or sand cement shall include a mechanical mixer or, if the ENGINEER approves hand mixing for cement grout, a watertight mixing platform or mixing box of adequate size.

3.02 PREPARATION OF FOUNDATION

- A. Immediately prior to the construction of riprap, the slopes or ground surface shall be trimmed within reasonably close conformity to the lines and grades indicated on the Drawings or as directed by the ENGINEER, and shall be thoroughly compacted by the use of hand or mechanical tamps.
- B. On slopes, the bottom of the riprap shall be placed at least 2 feet below the natural ground surface, unless otherwise shown or directed.
- C. No material shall be placed on a frozen or otherwise unsuitable slope.

3.03 PLACEMENT OF FILTER BLANKET

- A. Where shown on the Drawings, a filter blanket course shall be placed under the riprap on the prepared subgrade.
- B. Filter blanket shall be placed immediately prior to placement of riprap. Compaction of the filter blanket is not required except where called for on the Drawings.
- C. Where specifically permitted by the ENGINEER, a synthetic filter fabric may be substituted for the filter blanket course. Filter fabric shall be especially designed for use as slope stabilization under riprap and shall be acceptable to the ENGINEER. Placement of filter fabric shall be in strict conformance with the manufacturer's written instructions and recommendations.

3.04 MACHINE CONSTRUCTION OF PLAIN ROCK RIPRAP

- A. Unless otherwise shown on specified, plain rock riprap shall be constructed using a crane and clam-shell or other suitable equipment approved by the ENGINEER. The rock shall be placed as nearly as practicable in final position using powered equipment. If necessary, larger rocks shall be worked up to the surface when the material on the surface does not meet the weight specification or when the voids next to the foundation material are too large.
- B. The quantity of small stones shall be kept as low as possible, sufficient only to fill the voids between the larger stones. Care shall be taken that this small material is well distributed throughout the mass and not allowed to segregate or form pockets of small stone. All bridging shall be broken down. Large interstices, or open channels, or voids shall be filled by chinking or otherwise manipulating the stones.
- C. When riprap is to be built on existing riprap, special care shall be taken to provide positive anchorage of the new riprap to the existing riprap.
- D. The finished riprap surface shall in general conform to the slope lines shown on the Drawings. No objectionable, hazardous, or unsightly projections above the general place surface will be permitted.

3.05 CONSTRUCTION OF HAND PLACED, PLAIN ROCK RIPRAP

- A. Hand placed plain rock riprap shall be constructed upon the prepared foundation by hand placing so that the stones shall be as close together as is practicable in order to reduce the voids to a minimum. Construction of riprap on sloped surfaces shall begin horizontal layers.
- B. When rock riprap is constructed in more than one layer, it shall be so placed that it will be thoroughly tied together with the larger stones protruding from one layer into the other.
- C. The standard depth of rock riprap shall be 12 inches unless otherwise indicated or directed and in no instance shall be less than 10 inches in depth. Rock riprap shall have an average depth for each 25 square feet of surface of not less than the depth indicated on the Drawings or directed by the ENGINEER, or the standard depth required in these Specifications.
- D. Each stone shall be so placed that the depth will be perpendicular to the surface upon which it is set. The length shall be placed so that it will be against the adjoining stones. The stones shall be placed in such a manner as to stagger all joints as far as it is possible and practicable.
- E. The main stones shall be thoroughly chinked and filled with the smaller stones by throwing them over the surface in any manner that is practicable for the smaller stones to fill the voids. This work shall continue with the progress of the construction. Tamping of the stones will not be required if the stones have been placed in a reasonable and satisfactory manner.
- F. Knapping of the stones will not be required except stone protruding more than 4 inches above what is considered the normal surface of the stones, in which case these stone shall be broken down to come within 4 inches of the normal surface.

3.06 CONSTRUCTION OF GROUTED ROCK RIPRAP

- A. Grouted rock riprap shall constructed upon the prepared foundation using hand placement and the stone shall be set or placed are close together as is practicable in order to reduce the voids to a minimum. Construction of riprap on slopes shall begin at the bottom and shall progress upward in approximately horizontal layers.
- B. When rock riprap is constructed in layers, the layers shall be thoroughly tied together with large stones protruding from one layer into the other.
- C. The standard depth of rock riprap shall be 12 inches, unless otherwise indicated or directed, and in no instance shall be less than 10 inches in depth. Rock riprap shall have an average depth for each 25 square feet of not less than the depth indicated on the Drawings or as directed by the ENGINEER, or the standard depth required in these Specifications.

- D. Each stone shall be bedded with the depth perpendicular to the surface upon which it is set. The length shall be placed as directed by the ENGINEER and each main stone shall be placed against the adjoining stones with sides and ends in contact. The stone shall be placed in such a manner as to stagger all joints as far as it is possible.
- E. After a workable area of the riprap has been set, the stones shall be knapped to a uniform surface and voids shall be thoroughly chinked and filled with smaller stones and spalls. This work shall continue with the progress of the construction.
- F. The surface of the completed rock riprap shall not vary from the theoretical surface required by more than 2 inches at any point when tested with a 12-foot straightedge.
- G. After chinking and filling, the voids between the stones shall be completely filled with grout. Care shall be take to prevent earth or sand from filling the spaces between the stones before the grout is poured.
- H. This grout shall be mixed either in a one-bag mixer or larger, for not less than 1-1/2 minutes, or it may be mixed by hand in a watertight box of sufficient capacity to accommodate a batch of at least one bag of cement. Hand mixing shall be continued in a manner and for a period satisfactory to the ENGINEER.
- I. Immediately before pouring the grout, the stones shall be wetted by sprinkling. The grout shall be carefully poured into the voids between the stones. This work shall begin at the lower portions of the riprap and progress upward. The entire bottom line of voids shall be filled with grout before the next line of voids above is poured. The pouring of the grout shall be accomplished by the use of vessels of adequate size and shape. Broadcasting, slopping, or spilling of grout from the vessels on the surface of the riprap will not be permitted. Progress of pouring shall be sufficiently slow to prevent the grout from oozing from the voids and flowing over the surface. During the pouring operations and continuing until the grout has assumed its initial set fiber brooms shall be used to maintain a uniform distribution over the entire surface. The grouting operations shall continue until such a time as all the voids have been completely filled and the grout has set even with the surface of the riprap.
- J. As soon as any section of the grouted riprap has hardened sufficiently, it shall be cured by sprinkling with water until is has been covered with burlap, cotton or jute mats, earth or liquid-membrane forming compound. The mats or earth shall be maintained by soaking with water for a period of not less than 72 hours. The water used for wetting and curing the grouted riprap shall be free from salt or alkali.

3.07 CONSTRUCTION OF CONCRETE BLOCK RIPRAP

- A. Concrete blocks for riprap shall be constructed to the dimensions shown on the Drawings and in accordance with the applicable provisions of the section entitled "Cast-In-Place Concrete" of these Specifications.
- B. The concrete blocks shall be placed upon the prepared foundation by hand. Each block shall be bedded with the depth perpendicular to the surface upon which it is set, or placed and oriented as directed by the ENGINEER. Each block shall be placed against the adjoining blocks with sides and ends in contact. The blocks shall be placed in a manner that the joint will be staggered.
- C. The surface of the completed concrete block riprap shall not vary from the desired theoretical plane by more than ½ inch for adjoining blocks and by more than 2 inches at any point when tested with a 12-foot straightedge.

3.08 CONSTRUCTION OF SACKED SAND-CEMENT RIPRAP

- A. Sacked sand-cement riprap shall be constructed by placing sacks filled approximately ¾ full with a mixture of sand and cement on the prepared foundation. Sand and cement shall be mixed dry, with a mechanical mixer until the mixture is uniform in color. After the mixing has been completed, the sand-cement mixture shall be poured into sacks of approximately 1 cubic foot capacity until they are approximately ¾ filled. The sack shall then be securely fastened with hog rings by sewing or other suitable methods that prohibit leakage of the mixture from the bags.
- B. The sacks of sand cement shall be bedded, by hand, on the prepared grade with all the fastened ends on the grade and with the joints broken. The completed riprap shall have a minimum thickness of 10 inches, measured perpendicular to the slope. The surface shall not vary more than 3 inches above or below the desired theoretical plane.
- C. The sacks shall be rammed and packed against each other and tamped on the surface in such a manner as to form close contact and secure a uniform surface. Immediately after placing and tamping the sacks of sand cement, they shall be thoroughly soaked by sprinkling with water. Water shall not be applied under high pressure.
- D. Sacks of sand cement ripped or broken in placing shall be removed and replaced before being soaked with water.

3.09 PROTECTION OF STRUCTURES

All structures shall be carefully protected from damage by equipment or impact of stones or blocks. All damage shall be corrected by the CONTRACTOR at his own expense and in a manner acceptable to the ENGINEER.

**SECTION 02951
RAILROAD AND HIGHWAY CROSSINGS**

PART 1 - GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, materials, and equipment required to properly complete sewer and/or water pipeline construction under railroads and Federal or State highways, as described herein and/or shown on the Drawings.

1.02 SHOP DRAWINGS AND ENGINEERING DATA

Complete Engineering data and product information shall be submitted to the Engineer in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.03 STORAGE AND DELIVERY

All materials shall be stored and protected with strict conformance to the manufacturer's recommendations and as approved by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel casing pipe for sizes 6 inches and smaller shall conform to ASTM A-120 (standard weight), of the latest standard specifications.
- B. Steel casing pipe, sizes 8 inches through 54 inches, shall be spiral or straight seam welded steel pipe conforming to the latest revisions to ASTM A-139 Grade B.
- C. All steel casing pipe shall be bituminous coated inside and out.
- D. All corrugated metal casing pipe shall be hot dipped galvanized.
- E. Corrugated metal casing pipe shall conform to the following specifications depending on the type of crossing:
 - 1. HIGHWAY
 - a. Corrugated pipe material shall conform to the latest revision of ASTM A-444 (AASHTO M218).
 - b. The pipe shall be single riveted with circumferential (annular) seams and a full circular cross section.
 - c. the corrugations shall be 2-3/4-inch pitch by 1/2-inch depth.

- d. The minimum material thickness (including galvanizing) shall be 20 gauge or as specified in the Bid Schedule.
- e. All joints shall be connected with the standard type single piece band connector of the same material and coating as the pipe.
- f. All corrugated metal pipe shall conform to the latest revision of AASHTO M 190.

2. RAILROAD

- a. Corrugated metal pipe material shall conform to the latest revision of ASTM A-444.
 - b. The pipe shall be single riveted with circumferential (annular) seams and a full circular cross section.
 - c. The pipe shall have Class I corrugations and have a minimum material thickness of 18 gauge or as specified on Drawings or Bid Schedule.
 - d. All joints shall be connected with corrugated coupling bands fabricated of the same material as the pipe.
 - e. The pipe shall be coated with a bituminous coating.
 - f. All corrugated metal pipe and Bituminous Coating shall conform to the latest revision of the American Railway Engineering Association (AREA) Manual, Volume 1, Chapter 1, Part 4.
- F. Structural steel liner plates shall be used for excavated tunnels where the casing pipe is 54 inches or greater in diameter. Liner plates shall be of the thickness shown on the Drawings. Liner plates shall be of the two-flange, lap-joint type. All liner plates shall be hot-dipped galvanized in accordance with AREA 1-4-25 or AASHTO M167 and liner plates for railroad crossings shall be bituminous coated in accordance with AREA 1-4-13. The corrugations shall be 3-1/2 inches center to center. Bolts and nuts used shall be a minimum of 5/8-inch in diameter and shall conform to the latest revision of ASTM A307 for plate thickness less than 0.209 inch, and ASTM A449 for plate thickness equal to or greater than 0.209 inch. Each plate shall have one 2-inch diameter half coupling and plug for grouting.
- G. The sand fill between the casing pipe and carrier pipe, where permitted, shall conform to the section entitled "Cast-In-Place Concrete" Part 2.02B, SECTION 03310 (Fine Aggregate) of these Specifications.
- H. The void behind the casing pipe shall be filled with sand-cement grout. The sand-cement content shall be one part Portland Cement to 3 parts fine aggregate. The water-cement ratio shall be 0.62 by weight.

PART 3 - EXECUTION

3.01 GENERAL

- A. Any solidification of embankments, boring headings, or tunnel headings or sides shall be the Contractor's responsibility and shall be done at his own expense.
- B. Bored installations shall have a bored-hole diameter essentially the same as the outside diameter of the casing pipe to be installed.
- C. The casing pipe shall be jacked into the boring as soon as possible after the boring is made. Lengths of casing pipe as long as practical shall be used. Joints between sections shall be completely welded as recommended for joining the particular type of pipe.
- D. Once the jacking procedure has begun, it should be continued without stopping until completed, subject to weather and conditions beyond the control of the Contractor.
- E. Any replacement of carrier pipe in an existing casing shall be considered a new installation, subject to the applicable requirements of these Specifications.
- F. Open cut installations, where permitted, shall be in accordance with the details and procedures shown on the Drawings. For open cut installations, corrugated metal pipe may be substituted for casing pipe.
- G. Steel liner plates shall be installed in excavated tunnels when called for on the Drawings. The liner plates shall be installed progressively as excavation proceeds. Excavation shall not continue more than 24 inches past the end of the liner plate already in place. At this time an additional section of liner shall be installed before excavation shall continue. Grout shall be placed under pressure in the annular void as the excavation proceeds. Grout should be continuously placed as close to the heading as possible, using grout stops if necessary. Grout shall be injected in the lower holes first, moving upward as the back space is filled. Threaded plugs shall be installed after filling each grout hole.
- H. Care shall be taken to ensure that casing pipe installed by the boring and jacking method will be at the proper alignment and grade.
- I. The Contractor shall maintain and operate pumps, well points, and drainage system equipment to keep work de-watered at all times.
- J. Adequate sheeting, shoring, and bracing for embankments, operating pits, and other appurtenances shall be placed and maintained to ensure that work proceeds safely and expeditiously. Upon completion of the required work, the sheeting, shoring and bracing shall be left in place, cut off, or removed, as designated or directed by the Engineer.

- K. Trench excavation; mining for tunnels; all classes and types of excavation; the removal of rock, muck, debris; the excavation of all working pits; and backfill requirements of the section entitled "Earthwork" are included under this section.
- L. Carrier pipe for all lines 6 inches and larger shall have push-on joints and fittings.
- M. After the casing pipe or tunnel liner is installed; the carrier pipe shall be installed exercising care at all times to protect the interior of the casing pipe and to maintain tight, full seated joints in the carrier pipe. The carrier pipe shall be installed at the proper line and grade without any sags or high spots.
- N. The carrier pipe shall be held concentric with the casing pipe by the use of hardwood blocks or cast iron chocks spaced radially around the pipe and secured together so that they remain firmly in place. The spacing of such blocks longitudinally in the casing pipe shall not be greater than 10 feet.
- O. Except where prohibited, sand shall be forced under pressure into the annular space between the carrier pipe and the casing pipe. This shall begin at the center of the crossing and completely fill the space to each end. Care shall be exercised at all times to maintain the carrier pipe at its proper line and grade.

3.02 RAILROAD CROSSINGS

- A. The Contractor shall secure permission from the railroads to schedule work so as not to interfere with the operation of the railroads. All work will be done under the supervision of the Engineer and the railroads involved. The Contractor will furnish the railroad with such additional insurance as may be required, cost of the same to be borne by the Contractor.
- B. The casing pipe shall extend no less than 25 feet from the centerline of outside track to the end of the pipe. The casing pipe shall extend beyond the railway right-of-way limits, if necessary, to obtain this distance.
- C. All work on railway right-of-way including necessary supporting of tracks, safety of operations, and other standard and incidental operation procedures shall be under the supervision of the appropriate authorized representative of the railway system affected, if required, and any decisions of this representative pertaining to construction and/or operations shall be final and construction must be governed by such decisions.
- D. If, in the opinion of the railway company, it becomes necessary to provide flagging protection, watchmen, removal or replacement of tracks, or the performance of any other work in order to keep the tracks safe for traffic, the Contractor shall reimburse the railroad in cash for such services, in accordance with accounting procedures agreed on by the Contractor and affected railway company before construction is started.

3.03 HIGHWAY CROSSINGS

- A. The Contractor shall be held responsible and accountable for the coordinating and scheduling of all construction work within the State Highway right-of-way.
- B. Work along or across the State Highway Department rights-of-way shall be under the supervision of the Engineer and State Highway Department Engineer.
- C. All water and sewer pipelines installed under paved roads and paved crossroads within the rights-of-way of the State Highway Department shall be encased. This includes, but is not limited to, all water and sewer service lines.
- D. For open trench cut installations, the Contractor shall make satisfactory arrangements to detour traffic around the area of highway where work is in progress, with minimum inconvenience placed on the traveling public. The Contractor shall provide suitable flagmen, watchmen, safety devices, and other services and facilities as may be required by the State Highway Department. The cost of the same shall be borne by the Contractor.
- E. All water and sewer lines shall have a minimum cover of 30 inches unless otherwise shown on the Drawings, but in no case shall the minimum cover be less than that required by the regulations of the highway agency involved.
- F. Unless otherwise shown, encasement shall extend 5 feet beyond the highway embankment or back of side ditch. On curbed portions of conventional highways, the casing pipe shall extend to the back of curb or sidewalk.
- G. For open trench cut installations, the Contractor shall be responsible for scheduling and coordinating all construction work. All work at one particular crossing shall be completed with the trench backfilled, compacted, and a temporary crushed stone surface provided for traffic before any work is started on another such crossing.
- H. All installations shall be done to leave free flows in drainage ditches, pipes, culverts, or other surface drainage facilities of the highway, street, or its connections.
- J. Where sodding is disturbed by excavation or backfilling operations, such areas shall be replaced by mulch sodding on slopes 5 percent or less. All slopes over 5 percent shall be replaced with block sodding. No separate payment shall be made for sodding which shall be included in the bid prices for installation of pipe.
- K. All trench excavation within the right-of-way, but not under pavement, shall be backfilled by tamping in 6-inch layers.
- L. All surplus material shall be removed from the right-of-way and the excavation finished flush with surrounding ground.
- M. Grout backfill shall be used for unused holes or abandoned pipes.

- N. Boring, jacking, or driving of carrier or casing pipes under existing highways shall be accomplished without jetting, sluicing, or wet-boring.
- O. No excavated material or equipment shall be placed on the pavement or shoulders of the highway without the express approval of the State Highway Department Engineer.
- P. In no instance will the Contractor be permitted to leave equipment (trucks, backhoes, etc.) on the pavement or shoulder overnight. Construction materials to be installed which are placed on the right-of-way in advance of construction shall be placed in such a manner as not to interfere with the safe operation of the highway.

END OF DOCUMENT

SECTION 03110

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE

This Specification section prescribes materials and methods to be used in fabricating, erecting, and removing forms for cast-in-place concrete. The CONTRACTOR shall furnish all form design, forms, shoring, ties, form coating, and materials and all labor, equipment, and other items necessary or convenient to the CONTRACTOR for the fabrication, erection, and removal of formwork.

1.02 GENERAL

- A. Forms shall be fabricated, erected, and removed as specified herein and shall be of a type, size, shape, quality and strength to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. The forms shall be true to line and grade in accordance with the tolerances as specified in "Cast-In-Place Concrete" and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces.
- B. The responsibility for correctly assessing and analyzing the erection stresses induced upon the structure, its elements and supporting foundations during construction will be the total obligation of the CONTRACTOR. Since the ENGINEER does not dictate or determine the CONTRACTOR'S sequence of operations of construction, the ENGINEER cannot determine erection stresses and therefore assumes no responsibility or obligation to do so. The CONTRACTOR must employ or otherwise provide for adequate professional structural engineering supervision to determine erection stresses and notify the ENGINEER of the results of the study.
- C. The responsibility for adequate formwork design for construction of cast-in-place, reinforced concrete will be the total obligation of the CONTRACTOR. The CONTRACTOR shall employ competent professional engineering services to design formwork and supervise the erection of all formwork needed for the job.
- D. Except as modified herein, form design, fabrication, and erection shall conform to the requirements of ACI 347 and ACI 318 and shall be acceptable to the ENGINEER. Design criteria for plywood shall conform to APA Form V345.
- E. Formwork shall comply with the requirements of ANSI A10.9 and OSHA Construction Standards, Part 1926, "Subpart Q, Concrete, Concrete Forms, and Shoring."

1.03 SUBMITTALS

- A. When requested by the ENGINEER, the CONTRACTOR shall submit to the ENGINEER for review shop drawings and design calculations for formwork the CONTRACTOR intends to use in constructing the work. The CONTRACTOR shall furnish said shop drawings and design calculations at no additional cost to the OWNER.
- B. Prior to beginning concreting operations, the CONTRACTOR shall submit to the ENGINEER for approval engineering data and manufacturer's literature on all form ties, spreaders, bar supports, form coatings, and prefabricated steel forms intended for use in the work.

1.04 STORAGE

All form materials and accessories shall be stored above ground on framework or blocking and shall be covered with a suitable waterproof covering providing adequate air circulation and ventilation.

PART 2 - PRODUCTS

2.01 FORMS

- A. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard.
- B. Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes or wetwells. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.
- C. Forms for cast-in-place concrete shall conform with the following requirement:

- | | |
|------------------------------|--|
| 1. Prefabricated Steel Forms | Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", Universal "Uniform", or equal. |
| 2. Plywood | Product Standard PSI, waterproof resin-bonded, exterior type Douglas Fir. |
| a. Normal | Face adjacent to concrete Grade B or better |
| b. Architectural | Face adjacent to concrete Grade B or better with plastic overlay. |

PART 3 - EXECUTION

3.01 FABRICATION AND ERECTION

- A. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows. The forms shall produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.
- B. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- C. All form panels shall be placed in a neat, symmetrical pattern with horizontal joints level and continuous. The CONTRACTOR shall place special attention on mating forms to previously placed walls so as to minimize steps or rough transitions. Form panels shall be of the largest practical size to minimize joints and to improve rigidity.
- D. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs.
- E. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls the forms on one side shall not extend more than 2 feet above the joints.
- F. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection prior to concrete placement.
- G. Unless shown otherwise on the Drawings, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 3/4 inch by 3/4 inch chamfer formed by a wood or metal chamfer strip.
- H. Forms for exposed surfaces and all steel forms shall be coated with nonstaining form release agent which shall be applied just prior to placement of steel reinforcement. After coating, any surplus form release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating immediately before concrete placement, except in freezing weather form release coating shall be used.

- I. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measure shall be taken to insure acceptable lines and surface to required dimensions and cross sections.
- J. If any forms bulge or show excessive deflection, in the opinion of the ENGINEER, the concrete shall be removed and the forms rebuilt and strengthened.

3.02 FORM REMOVAL

- A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.
- B. No forms shall be removed without the approval of the ENGINEER. In general and under normal conditions, the ENGINEER will approve removal of forms after the following time has elapsed:

ITEM	TIME AFTER PLACEMENT
Elevated Slabs and Beams	14 days
Columns	7 days
Walls	3 days
Other Concrete	2 days

- C. When ambient air temperatures during the curing period fall below 45 degrees F., form removal will take place based on job-cured test cylinder strength only.
- D. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified in "Cast-In-Place Concrete" of these Specifications.

SECTION 03240

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SCOPE

This specification section describes steel reinforcement to be furnished and installed in cast-in-place concrete. The CONTRACTOR shall furnish all steel reinforcement, supports, and materials and all labor equipment, and other items necessary or convenient to the CONTRACTOR for the proper installation of the reinforcement.

1.02 GENERAL

- A. Steel reinforcement shall be designed, detailed, fabricated and placed in conformance with all applicable requirements of ACI 315, ACI 318, and CRSI Manual of Standard Practice.
- B. No concrete shall be placed until all steel reinforcement to be covered has been inspected in place and approved by the ENGINEER.

1.03 SUBMITTALS

- A. Prior to placing any steel reinforcement, the CONTRACTOR shall submit to the Engineer written evidence that the steel reinforcement has been tested and is in conformance with the material and mechanical requirements specified herein. Certified copies of mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Contractor to furnish, at no additional cost to the OWNER, test results from an independent testing laboratory acceptable to the ENGINEER on mill samples or delivered steel reinforcement. Mill or laboratory test results for verifying compliance with this specification section shall be provided for each 15 tons of steel reinforcement shipped. Results of laboratory or mill tests submitted to the ENGINEER shall be of tests conducted not earlier than 90 days prior to delivery.
- B. The cost of all sampling and testing of steel reinforcement necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.
- C. Prior to fabrication and bending of steel reinforcement, the CONTRACTOR shall submit to the ENGINEER for review and approval complete shop drawings, bending diagrams, and schedules of all steel reinforcement to be incorporated in the work.
- D. The reinforcement shop drawings and bending diagrams shall show all dimensions, details, notes, location, size, length, and each bar mark, together

accessories and other materials belonging to the reinforcement for the concrete. Schedules shall show all information and be of the same general form as those on the Drawings. Concrete walls shall be detailed in elevation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. REINFORCING BARS

Reinforcing bars shall be deformed billet-steel bars conforming to ASTM A 615. All bars #4 and larger shall be Grade 60. All bars #3 and smaller shall be Grade 40. All bars shall be shop fabricated and bent cold. Bars shall be free from defects and kinks and from bends not indicated on the Drawings or approved bending diagrams.

B. MESH REINFORCEMENT

Mesh reinforcement shall be electrically-welded, cold-drawn, mild-steel, plain wire fabric conforming to ASTM A 185. Wire shall be cold-drawn steel conforming to ASTM A 82.

C. SUPPORT CHAIRS

Reinforcement supports shall conform to Product Standard PS7 and CRSI Manual of Standard Practice, Class D or E.

Reinforcement support chairs shall be stainless steel or shall be plastic-tipped when used in walls and elevated slabs. Support chairs used in slabs on grade shall be stainless steel or shall be hot-dip galvanized after fabrication or plastic-tipped in such a manner as to provide a minimum 1-1/2 inches of protection from the subgrade. Nails shall not be used to support reinforcement.

D. TIE WIRE

Tie wire shall conform to Federal Specification QQ-W-461 and shall be of black annealed steel, 16-gauge minimum.

PART 3 - EXECUTION

3.01 DELIVERY AND STORAGE

- A. Reinforcement shall be delivered to the job site carefully bundled and tagged for identification. Reinforcement shall be stored at least 12 inches above ground on timber mats or other supports acceptable to the ENGINEER. Contact between reinforcement and the ground shall not be permitted during storage. Reinforcement shall be supported so as not to bend or deflect excessively under its own weight.

3.02 SURFACE PREPARATION

Before placement, all reinforcement shall be thoroughly cleaned of oil, dirt, mill scale, rust scale, and other coatings that would tend to destroy or reduce bond. A thin coating of orange rust resulting from short exposure will not be considered objectionable; but any reinforcement having heavy rust scale or thick rust coating shall be thoroughly cleaned to the satisfaction of the ENGINEER or shall be ejected and removed from the job site. When there is a considerable delay between placement of reinforcement and placement of concrete, the reinforcement shall be reinspected prior to placement of concrete and recleaned if necessary.

3.03 PLACEMENT

- A. Reinforcement shall be accurately positioned and tied at intersections with annealed wire or suitable clips approved by the ENGINEER. Reinforcement shall be supported by concrete or metal chairs, stays, spacers, hangers, or other supports acceptable to the ENGINEER.
- B. Reinforcing bars shall be fastened with wire ties at a minimum of three places per bar. Bars shall be tied at every intersection around the periphery of slabs. Wall steel shall be tied at every fourth intersection as a minimum.
- C. Reinforcement supports shall have sufficient strength and stability to maintain the reinforcement in place throughout placement and concreting operations. Supports and ties shall not be exposed at the face of the concrete nor shall they discolor the surface of the finished concrete.
- D. Movement of steel reinforcement in place during concreting operations shall be prevented. Any reinforcement which is displaced shall be accurately repositioned in the proper place before being completely covered.
- E. Dowels for successive work shall be securely fastened in correct position before placing concrete. The sticking of dowels after placing concrete shall not be permitted.
- F. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.
- G. No bar partially embedded in concrete shall be field-bent unless approved by the ENGINEER.

3.04 MINIMUM COVER AND CLEARANCE

The minimum concrete cover for the protection of embedded steel reinforcement shall be as follows:

- A. Surfaces cast against crushed rock, sand, or earth:
- | | |
|---------------|----------|
| All bar sizes | 3 inches |
|---------------|----------|
- B. Surfaces exposed directly to water, backfill, or weather after form removal:
- | | |
|---------------|----------|
| All bar sizes | 2 inches |
|---------------|----------|
- C. Surfaces not exposed directly to water, backfill, or weather after form removal:
1. Elevated Slabs 1 inch
 2. Floors, Walkways, Pavement 1-1/2 inches
 3. Walls

Less than 12 inches thick	1-1/2 inches
12 inches or thicker	2 inches
 4. Beams

Stirrups	1-1/2 inches
Principal Reinforcement	2 inches

The minimum clearance between adjacent parallel bars shall not be less than the nominal diameter of the bars, not less than 1.5 times the maximum course aggregate size, and not less than 1 inch in beams, 1-1/2 inches in columns, and 2 inches in other locations.

3.05 TOLERANCES

- A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE	
Sheared Length of Bars	+1"	-1"
Depth of Truss Bars	+0.0"	-1/2"
Outside Dimensions of Stirrups, ties, and Spirals	+1/2"	-1/2"
Location of Bends	+1"	-1"

- B. Allowable tolerances for placing steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE
Concrete Cover from Outside of Bar to Finished Surface	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Beams and Joists	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Slabs and Walls	+1" -1"
Spacing of Stirrups, Ties, and Spirals along Longitudinal Axis of Member	+1/2" -1/4"
Height of Bottom Bars in Slabs, Beams, and Joists	+1/4" -1/4"
Height of Top Bars in Slabs, Beams, and Joists	
Depth 8" and less	+1/4" -1/4"
Depth 9-24"	+1/2" -1/2"
Depth 25" and greater	+1" -1"

3.06 SPLICES

- A. Splices in reinforcement shall conform to the requirements of ACI-318, Chapter 7, Details of Reinforcement. Unless otherwise shown on the Drawings, all bars shall be lapped a minimum of 36 bar diameters where splicing is necessary and splices shall be staggered. Except where indicated on the Drawings, welding or tack welding of reinforcement shall not be permitted. Lapped connections shall be sufficient to transfer the full stress between the bars by bond and shear and to develop the full strength of the bars. In slabs and beams no splices shall be made at points of maximum positive or negative moment, and in no case shall adjacent bars be spliced at the same place.
- B. Although tolerances are allowed in the lateral spacing of parallel bars in the plane of reinforcement layers and in the spacing of stirrups, ties, and spirals along the longitudinal axis of a member, in no case shall the number of bars per layer of reinforcement provided in walls and slabs be less than the lateral dimension on the wall or slab in the plane of the reinforcement layer divided by the specified spacing, nor shall the number of stirrups, ties, or spirals provided along the longitudinal axis of a member in a given segment be less than the length of the segment divided by the specified spacing.

- C. Welded wire fabric reinforcement shall be lapped a minimum of 6 inches at joints and shall be wired securely. Mesh shall extend to within 2 inches of sides and ends of slabs. Lapped ends of welded wire fabric shall be offset to prevent continuous laps. Splices shall not be made midway between supporting beams or directly over beams of continuous structures.

****END OF SECTION****

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**SECTION 03310
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.01 SCOPE

This specification section covers all materials, equipment, and methods to be used by the CONTRACTOR in mixing, placing, testing, finishing, and curing cast-in-place concrete. The CONTRACTOR shall furnish all cement, aggregate, water, admixtures, and other materials and all labor, equipment, and supplies necessary or convenient to him for completing the work described in these Contract documents.

Cast-in-place concrete reinforcement and form work shall be as specified in the sections entitled "Cast-In-Place Concrete Reinforcement" and "Concrete Formwork" respectively of these Specifications.

1.02 CLASSIFICATION OF CONCRETE

Concrete shall be either Class A or Class B, as indicated on the Drawings or specified in these Specifications. If the class is not otherwise specified, the CONTRACTOR shall furnish Class A concrete.

In general Class A concrete shall be used for reinforced concrete cast-in-place in forms for slabs, footings, foundations, manholes, and similar reinforced concrete structures coming under the scope of ACI 318. Class B concrete shall be plain concrete and shall be used for pipe cradles, pipe and conduit encasement, bedding, grade correction, anchors, collars, thrust blocks, massive sections, and other non-reinforced concrete.

1.03 GENERAL REQUIREMENTS

All cast-in-place concrete shall be accurately formed and properly placed and finished as shown on the Drawings and specified herein.

The materials, aggregate grading, cement content, and placement methods specified herein are intended to provide a concrete that satisfies the minimum strength requirements, exhibits sufficient plasticity and cohesiveness to facilitate placement and reduce honeycombing and porosity, and incorporate a minimum water-to-cement ratio to minimize bleeding and shrinkage and to provide maximum water tightness. However, the CONTRACTOR may submit to the ENGINEER for review and approval alternate material requirements and placement techniques for achieving the desired results.

All Class A cast-in-place concrete shall be designed in accordance with the applicable requirements of ACI 318, latest edition.

1.04 PRELIMINARY MIX DESIGN

Before starting any concreting operations, the CONTRACTOR shall submit to the ENGINEER for approval a preliminary mix design for each class of concrete and for each size and gradation of aggregate and each consistency within a given class of concrete

intended for use in the work. The preliminary mix design submittals shall contain the following information for each: (including those items listed in the latest ASTM designations, if different from those specified)

A. FINE AGGREGATE (Sample per ASTM D 75)

1. Source and type
2. Sieve analysis per ASTM C 136
3. Magnesium sulfate soundness per ASTM C 88
4. Deleterious substance per ASTM C 117, C 123, and C 142
5. Saturated surface dry weight per cubic yard of concrete
6. Bulk specific gravity per ASTM 127
7. Fineness modulus as defined in ASTM C 125

B. COARSE AGGREGATE (Sampled per ASTM D 75)

1. Source and type
2. Sieve analysis per ASTM C 136
3. Abrasion loss per ASTM C 535
4. Magnesium sulfate soundness per ASTM C 88
5. Deleterious substances per ASTM C 117, C 123, AND C 142
6. Saturated surface dry weight per cubic yard of concrete
7. Bulk specific gravity per ASTM 128

C. CEMENT (Sampled per ASTM C 183)

1. Manufacturer, type, and ASTM designation
2. Sacks per cubic yard of concrete
3. Total gallons of water per sack (cu.ft.) of cement
4. Compressive strength at 7 days per ASTM C 109
5. Chemical analysis per ASTM C 114

- D. SLUMP per ASTM C 143
- E. AIR CONTENT per ASTM C 231
- F. UNIT WEIGHT per ASTM C 138
- G. TIME TO INITIAL SET at 70 Degrees F. per ASTM C 403
- H. COMPRESSIVE STRENGTH at 7, 14, and 28 days ages per ASTM C 192, and C 39. A total of 9 standard test cylinders shall be prepared and cured in the laboratory for each preliminary mix design, three of which shall be tested each at 7-, 14-, and 28-day ages.

I. ADMIXTURES

1. Manufacturer, type, and ASTM designation
2. Dosage and point of introduction into the mix.

A preliminary mix design shall not be considered acceptable if the concrete resulting from that mix design does not produce an average 28-day compressive strength at least 1,200 psi higher than that required, unless a standard deviation for compressive strength testing has been established for the concrete supplier using the methods described in ACI 214. If a standard deviation has been established, the strength used as a basis for selecting concrete proportions shall exceed the required 28-day strength by the amounts given in ACI 318, Section 4.2.2.1, based on the appropriate value of the standard deviation. If a standard deviation is utilized, the CONTRACTOR or concrete supplier shall furnish written evidence to the ENGINEER that the standard deviation has been determined in accordance with the methods described in ACI 214. A written statement from an independent testing laboratory may be considered satisfactory evidence of compliance.

Tests for compressive strength and all sampling and testing of aggregate and cement shall be conducted in accordance with the specified ASTM standards by an independent testing laboratory acceptable to the ENGINEER. Alternately, when approved by the ENGINEER, testing of cement and aggregate may be conducted at the point of manufacture by reputable cement and aggregate suppliers who regularly provide such testing services by experienced, competent personnel.

Tests for slump, air content, unit weight, and time to initial set may be conducted by the concrete supplier, providing such tests are performed in accordance with the specified ASTM standards by experienced, competent personnel using proper equipment.

The CONTRACTOR shall submit with each preliminary mix design four (4) copies of certified laboratory or mill test reports on all aggregate and cement incorporated in the preliminary mix design and four (4) copies of certified laboratory test reports on the compressive strength of the resulting concrete. Test

reports on aggregate and cement shall contain written evidence that clearly indicates that all cement and aggregate covered by the test reports conform in all respects to the applicable material requirements of this specification section.

Approval of the preliminary mix designs shall in no way be interpreted to relieve the CONTRACTOR of any responsibilities, duties, or obligations for providing concrete conform in to the requirements of this specification section.

If, during the course of concreting operations, the CONTRACTOR desires to use an alternate mix design differing from the approved mix design in order to obtain a desired workability, density, strength, or uniformity, he shall submit to the ENGINEER for approval the information specified herein on the proposed alternate mix design prior to its use.

If, based on the result of laboratory or field tests conducted during concreting operations, concrete prepared according to an approved mix design fails to satisfy the requirements of this specification section, the ENGINEER shall have the right to require that the CONTRACTOR develop and submit in the manner specified an alternate mix design that will provide concrete conforming to the requirements of this section. The need for a change in mix design will be based on the ENGINEER'S statistical analysis and interpretation of laboratory and field tests conducted during concreting operations. Statistical methods and interpretation of test results will be as described in ACI 214, and ACI 318, latest edition.

Any increased material costs resulting from changes in mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.

The cost of all materials, labor, equipment and all sampling and testing services required for the preliminary mix designs or for alternate mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.

1.05 QUALITY CONTROL DURING CONSTRUCTION

A. CERTIFICATION OF MATERIAL COMPLIANCE

During concreting operations, the CONTRACTOR shall furnish the ENGINEER written evidence that clearly indicates that the cement and aggregate used in each batch of concrete delivered to or mixed at the job site conforms in all respects to the applicable material requirements of this specification section. Satisfactory certified mill test reports from the cement or aggregate supplier may be considered as evidence of compliance provided that such testing is performed in accordance with the specified ASTM standards by experienced, competent personnel on a regular basis. In case of doubt as to the adequacy or accuracy of mill tests, the ENGINEER may require that the CONTRACTOR furnish, at no additional cost to the OWNER, test reports on the cement and aggregate from an independent testing laboratory acceptable to the ENGINEER. Certified reports or certificates indicating compliance of cement and aggregate shall be submitted to the ENGINEER before such materials are incorporated

into the work. The CONTRACTOR shall be responsible for any delays in the progress of the work due to delays in testing and reporting.

Certified reports submitted to the ENGINEER for laboratory or mill tests on cement and aggregate shall be based on tests conducted not earlier than 90 days prior to incorporation of these materials into the work.

The cost of all sampling and testing of cement and aggregate necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.

B. FIELD SAMPLING AND TESTING

During concreting operations, the ENGINEER will periodically require additional field inspection, sampling, and testing of cement, aggregate, and/or concrete by an independent testing laboratory in order to determine if the requirements of this specification section are being satisfied.

Field sampling and testing of cement, aggregate, and concrete will be performed according to the following latest ASTM Standards at a frequency determined by the ENGINEER.

1. AGGREGATE

- a. Sampling ASTM D 75
- b. Testing Any test specified in ASTM C 33

2. CEMENT

- a. Sampling ASTM C 183
- b. Testing Any test specified in ASTM C 150

3. CONCRETE

- a. Sampling ASTM C 172
- b. Slump Test ASTM C 143
- c. Air Content Test ASTM C 231
- d. Making and Curing
 Test Cylinders ASTM C 31
- e. Compression
 Strength Tests ASTM C 39

Compressive strength testing will consist of making, curing, and testing cylinders of concrete. A total of four test cylinders will be prepared from each sample of concrete to be tested. Two test cylinders will be broken at an age of 7 days, two test cylinders will be broken at an age of 28 days. The minimum number of samples and test cylinders to be taken is as follows:

Concrete Class	Total Size of Pour	Number of Samples	Number of Cylinders
	03310-5		

Class A	1-4 cu. yds.	1	4
Class A or B	4-100 cu. yds.	1	4
Class A or B	101-200 cu. yds.	2	8
Class A or B	201-300 cu. yds.	3	12
Class A or B	Over-300 cu. yds.	1/100 cu.yd.	4/100 cu.yd.

Test cylinders will normally be laboratory-cured. However, the ENGINEER may require tests on field-cured specimens to check the adequacy of curing operations.

A slump test and an air content test will be performed on each sample of concrete tested for compressive strength.

Cement and aggregate will be subject to inspection, sampling, and field testing at the batching plant. Concrete will be subject to inspection, sampling, and field testing at the place of concrete placement. All field sampling, field testing, making and curing of field test cylinders, and laboratory testing performed during concreting operations for the purpose of determining if the requirements of this specification section are being satisfied shall be conducted by an independent testing laboratory selected by the OWNER and paid for directly by the OWNER and not as a part of this Contract.

The CONTRACTOR shall furnish the testing laboratory representative satisfactory samples of cement, aggregate, and concrete for inspection and testing purposes. The CONTRACTOR shall furnish any barrows, shovels, mixing boards, shaded area for preparing test cylinders, and similar equipment required by the testing laboratory representative for securing samples, making test cylinders, and conducting field tests.

No materials or concrete which fail to conform to the requirements of this specification section shall be incorporated into the work.

1.06 SHOP DRAWINGS AND ENGINEERING DATA

Complete ENGINEERING and product data shall be submitted to the ENGINEER on all admixtures, curing compounds, hardeners, sealers, and waterstops in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.07 GUARANTEE

Provide a guarantee against defective or deficient workmanship and materials in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

Concrete shall be composed of Portland Cement, fine aggregate, coarse aggregate, admixtures as specified herein, and water, so proportioned and mixed as to produce a plastic, workable mixture meeting the requirements of this specification section.

Materials and concrete not conforming to the requirements specified herein shall not be incorporated in the work.

2.02 MATERIALS

A. CEMENT

All cement used in cast-in-place concrete shall be Portland Cement conforming to the requirements of ASTM C 150, and, unless otherwise approved by the ENGINEER, shall be Type 1. No cement of dark color shall be used. No re-sacked, lumpy or partially set cement shall be used. Each sack of cement shall contain not less than 94 pounds (net) of cement, and each sack of cement shall be deemed to have a volume of 1 cubic foot; and each 94 pounds, if weighed or measured in bulk, shall be deemed to have a volume of 1 cubic foot.

B. FINE AGGREGATE

Fine aggregate shall be natural siliceous river sand, consisting of hard, clean, sharp, strong, durable and uncoated particles, conforming to the requirements of ASTM C 33. The mortar strength developed in such test shall be 90 percent of that developed by standard Ottawa sand tested under identical conditions.

Fine aggregate shall be graded in conformance with the requirements of ASTM C 33, except that it shall have a fineness modulus of 2.40 minimum and 3.00 maximum and the material passing the No. 200 sieve shall not exceed 3.0 percent by weight of the total sample. Coal and lignite shall not exceed 0.5 percent by weight of the total sample for all concrete. The fineness modulus of fine aggregate incorporated in the work shall not vary more than 0.10 plus or minus from the fineness modulus of the fine aggregate in the appropriate preliminary mix design approved by the ENGINEER.

If the locally available sources of fine aggregate will not yield the required grading, the ENGINEER may approve alternate gradations if such deviations do not adversely affect the work. However, the amount retained on any individual sieve size shall not exceed 35 percent of the sample and the amount passing the No. 50 sieve shall not be less than 15 percent of the sample.

C. COARSE AGGREGATE

Coarse aggregate shall consist of clean, natural, washed gravel or crushed stone suitably processed and conforming to the requirements of ASTM C 33, Class Designation 3S.

Coarse aggregate as delivered to the mixing plant shall be graded, or individual sizes shall be so combined as to fall within the grading requirements corresponding to the following grading size numbers, as contained in Table 2 of ASTM C 33:

Maximum Aggregate Sizes, Inches	Grading Size No.
3/4	67
1	57
1-1/2	467
2	357

The maximum size of aggregate shall be no larger than one-fifth of the narrowest dimension between sides of forms within which concrete is to be cast nor larger than three-fourths of the minimum clear spacing between reinforcing bars, or between bars and forms. Coarse aggregate shall be limited to 3/4 inch maximum size for pumped concrete.

D. WATER

Water used in mixing concrete shall be fresh, clean, potable water free from injurious amounts of oil, acid, alkali, vegetable, sewage, and/or organic matter. Water shall be considered as weighing 8.33 pounds per gallon.

E. ADMIXTURES

All concrete shall contain an air entraining admixture conforming to ASTM C 260 in order to provide an entrained air content of 5 + 1 percent by volume. Air entraining admixtures shall be W. R. Grace "Darex AEA", Master Builders "MB-VR", Protex "AES", Sika "AEA", or equal.

All concrete shall contain a chloride-free, water reducing admixture or plasticizer conforming to ASTM C 494, Type A. Water reducing admixtures shall be W. R. Grace "WRDA-HC", Sika "Plastocrete", Gifford-Hill "PSI Normal", Master Builders "Pozzoloth Normal", Chem-Masters "WR-77", or equal.

Accelerators and retarders may be used under adverse placement conditions when authorized in writing by the ENGINEER. Accelerators shall be calcium chloride conforming to ASTM D 98, dispensed as a solution. Calcium chloride content shall not exceed 1 percent of the cement content by weight. Retarders shall be chloride-free water reducing and retarding admixtures conforming to ASTM C 494, Type D. Retarders shall be W. R. Grace "Daratard-HC", Sika "Plastiment", Protex "Protard", Gifford-Hill "PSI Retarder", Master Builders "Pozzoloth Retarder", or equal.

The admixture content, batching method, and time of introduction into the mix shall be in strict accordance with the manufacturer's recommendations.

2.03 MEMBRANE CURING COMPOUND

Membrane curing compound shall have a 100 percent resin base and shall be of the colorless type with a fugitive dye added conforming to ASTM C 309, Type I, Class B. The membrane curing compound shall contain sufficient dye to produce a definite, distinguishing color. Curing compound shall be compatible with liquid hardeners and epoxy sealers.

Membrane curing compound shall be Protex "LR-151", Sonneborn "Hydrocide-309", W. R. Grace "Horncure 30D", Chem-Masters "Kurex 3", or equal.

2.04 POLYETHYLENE FILM

Polyethylene film shall conform to Product Standard PS 17 and, unless otherwise specified or shown on the Drawings, shall have a thickness of 6 mils.

2.05 EPOXY BONDING AGENT

Epoxy bonding agents shall be specially formulated to bond fresh concrete to existing concrete. Epoxy bonding agents shall be two-component polysulfide or polyamide epoxies containing 100 percent solids. Epoxy bonding agents shall be insensitive to moisture during cure. When cured at a temperature of 63 Degrees F., neat epoxy bonding agent shall have a one-day compressive strength of not less than 5,000 psi and a 28-day compressive strength of not less than 12,000 psi, when tested in accordance with ASTM D 695, and shall have a 28-day tensile strength of not less than 3,500 psi, when tested in accordance with ASTM D 638.

2.06 WATERSTOPS

Waterstops shall be manufactured of PVC and shall be of the ribbed type with center bulb. Waterstops shall have a nominal width of 6 inches and shall be as manufactured by W. R. Meadows, Vulcan Metal Products; W. R. Grace; or equal. Waterstops placed in concrete shall be continuous. Lapped joints shall not be permitted.

2.07 CHEMICAL HARDENER

Unless otherwise specified, all interior concrete floors of shops, garages, and vehicle service areas shall be treated with a liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant for improved wetting penetration. Liquid hardener shall be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent toppings and/or coatings. Liquid hardener shall be suitable for use on new or old concrete floors and shall comply with Corps of Engineer Specification 204. Liquid hardener shall be Sonneborn "Lapidolith", Protex "Lithoplate", L & M "Fluo Hard", or equal.

2.08 EPOXY FLOOR SEALER

Epoxy floor sealer shall be a two-component, 100 percent solids, epoxy coating that provides a smooth, tough, flexible, wear abrasion, and chemical resistant surface. Epoxy floor sealer shall be applied only where shown on the Drawings. Sealer shall be U.S.D.A. approved for use in food processing plants. Unless otherwise specified, sealer shall be colored gray. Epoxy sealer shall be Chem-Masters "Durakote", Sonneborn "Sonoplex", L&M "Dynaflor", or equal.

2.09 VAPOR BARRIER

Unless otherwise specified, all interior concrete slabs on grade in buildings shall be furnished with an FHA approved vapor barrier under the concrete slab. Vapor barrier shall be constructed of a multi-ply lamination of polyethylene film and glass scrim reinforced paper to form a moisture, scuff, and puncture resistant membrane. Moisture permeance shall not exceed 0.10 perms in accordance with ASTM E96, Procedure A. Vapor barrier shall be St. Regis Paper Company "Moistop", Glas-Kraft "Plybar", or equal.

2.10 STRENGTH

Concrete ingredients shall be selected, proportioned, and mixed in such a manner as will produce a watertight durable concrete that will develop the following minimum compressive strengths at an age of 28 days when sampled, cured, and tested in accordance with the procedures specified in ASTM C 31 and C 39:

Class of Concrete	AGE	Average of Three Consecutive Specimens	Minimum Any One Specimen
A	28 days	4,000 psi	3,500 psi
B	28 days	2,500 psi	2,000 psi

Should the average compressive strength of three consecutive specimens or the compressive strength of any single specimen fall below the minimum strengths specified above, the ENGINEER shall have the right to order a change in the mix design for the remaining portion of the work. The ENGINEER shall also have the right to order additional curing of the affected concrete followed by cores taken in accordance with ASTM C 42 and ACI 318, all at the expense of the CONTRACTOR. If the additional curing does not bring the average compressive strength of three cores taken in the affected area to at least the minimum strength specified, the ENGINEER may require that the CONTRACTOR strengthen the structure by means of additional concrete and steel or he may require that the CONTRACTOR replace the affected portions. The cost of all such changes in mix designs and any modifications to or replacement of deficient concrete shall be borne by the CONTRACTOR at no additional cost to the OWNER.

2.11 CONSISTENCY

Concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading and without permitting the materials to segregate or free water to collect on the surface. When dropped from the discharge chute, the concrete mass should flatten out at the center and spread out slowly at the edges.

The proportions shall be adjusted to secure the lowest water-cement ratio which is consistent with good workability, a plastic cohesive mixture, and one which is within the following slump range as determined in accordance with ASTM C143:

CONCRETE USE	SLUMP IN INCHES
Walls	2-1/2 - 4
Floors and Slab	2 - 3
Beams	2 - 3
Blocks and Footings	2 - 4

Concrete having a slump greater than one inch over the specified maximum shall be rejected.

In pumped concrete the maximum slump of the concrete at the suction of the pump may be increased above the maximum specified slump by the amount of slump loss in the pumping system up to a maximum of one inch. The amount of slump loss shall be the difference between slump tests made at both ends of pumping system, and shall be limited to a total loss of one inch. If tests indicate a loss greater than one inch, the CONTRACTOR shall take corrective measures acceptable to the ENGINEER.

For thin sections and construction with limited clearance between reinforcing steel and when placement conditions preclude the use of vibrators, the ENGINEER may authorize the use of concrete having a slump of 5 inches.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

Cement shall be shipped to the site of the mixer plant in bulk or in paper or cloth bags, at the option of the CONTRACTOR. Upon arrival it shall be stored immediately in a thoroughly dry, weather-tight and properly ventilated building or enclosure with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment. If cement is to be stored at the job site, storage facilities shall be provided by and at the expense of the CONTRACTOR and approved by the ENGINEER prior to arrival of the first shipment. Cement which has become caked or lumpy shall not be used.

Sand and coarse aggregates shall be stored in separate stockpiles at points selected to provide maximum drainage and to prevent the inclusion of a foreign material during rehandling. Stockpiles of coarse aggregates shall be built in horizontal layers to avoid

segregation and breakage. Where concrete volumes require batching of various aggregate sizes, a separate stockpile for each size shall be maintained. The bottom 6 inches of aggregate piles shall not be used.

3.02 PROPORTIONING

Concrete materials shall be accurately proportioned and mixed to produce a homogeneous and workable mixture having the consistency and minimum compressive strength specified herein.

Concrete materials shall be proportioned by weight. The types of equipment and methods used for measuring ingredients shall be acceptable to the ENGINEER.

The amount of water and cement used shall be the minimum amount necessary to produce a concrete mixture of the required strength and consistency, but in no case shall the water-to-cement ratio exceed that specified herein nor shall the cement content be less than that specified herein.

Compressive strength may not necessarily be the most critical factor in proportioning concrete mixes since other factors, such as durability and watertightness, may impose lower water-cement ratios than are required to meet strength requirements. In such cases compressive strength will, of necessity, be in excess of that specified.

Minimum cement contents and maximum water-to-cement ratios shall be as follows:

Factor	Class of Concrete	Maximum Aggregate Size			
		2"	1-1/2"	1"	3/4"
Minimum Cement Factor Sacks/cu. yd.	A	5.3	5.8	6.2	6.6
	B	5.0	5.5	5.9	6.3
Maximum Water-to-Cement Ratio, lb./lb.	A	0.49	0.49	0.49	0.49
	B	0.62	0.62	0.62	0.62
Maximum Water-to-Cement Ratio, Gal./Sack	A	5.5	5.5	5.5	5.5
	B	7.0	7.0	7.0	7.0

The water content of the mix shall be based on the total amount of water in the mixture, including any free water in the aggregate or adhering to the surface of the aggregate, but not including water absorbed by the aggregate.

The total volume of aggregate to be used in each cubic yard of concrete shall be determined by recognized standards for designing concrete mixes, utilizing the actual screen analysis of the aggregates.

The proportion of fine and course aggregate shall be such that the ratio of the course to the fine based on weight shall not be less than 1.0 nor more than 2.0, nor shall the amount of coarse material be such as to produce harshness in placing or honeycombing in the structure.

3.03 MIXING CONCRETE

The mixing equipment used by the CONTRACTOR shall be capable of combining the aggregates, cement, admixtures, and water within the time specified into a thoroughly mixed and uniform mass.

Concrete shall be mixed by one of the three following methods: (1) by the operation of one or more batch-type mixing plants, each with a rated capacity of 1/2 cubic yard or more, installed at the site of the work; (2) by the operation of a proportioning plant installed in the vicinity of the work and the use of transit mixers for mixing concrete and transporting it to the forms; or (3) by the use of ready-mixed concrete from a central mixing and proportioning plant. The method selected by the CONTRACTOR shall be subject to the approval of the ENGINEER.

The mixing and proportioning plants shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete and for readily changing the proportions to conform to the varying conditions and requirements of the work.

A. STATIONARY MIXED CONCRETE

Stationary mixing shall be done in a batch mixer of approved type which will ensure a uniform distribution of the materials throughout the mass. The equipment at the mixing plant shall be so constructed that all materials including the water entering the drum can be accurately proportioned and be under control. The cement and aggregate shall be proportioned by weight. No volumetric batch shall be allowed. The mixer shall be equipped with an automatic timing device made to lock the discharge level before aggregate and cement enter the drum, and to release such level only after the specified mixing time has elapsed. Stationary mixers shall be in accordance with the "Concrete Mixer Standards" adopted by the Mixer Manufacturer's of the Associated General CONTRACTORS of America and shall bear a plate giving the manufacturer's rated capacity of the mixer.

The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer. Mixing of each batch shall continue for the period indicated herein, during which time the drum shall rotate at a peripheral speed as recommended by the manufacturer.

The mixing time shall be as follows:

Capacity of Mixer	Mixing Time in Minutes
1/2 cubic yards	1-1/4
3/4 to 1 1/2 cubic yards	1-1/2
Larger than 1-1/2 cubic yards	2

The mixing time shall be measured from the time that all cement and aggregates and most of the water are in the mixer. Excessive over mixing, requiring additional water to preserve the required consistency will not be permitted. All of the mixing water shall be introduced before one-fourth of the total mixing time has elapsed.

B. TRANSIT MIXED CONCRETE

The type, capacity, and manner of operation of the mixing and transporting equipment for transit ready-mixed concrete shall conform to the current "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mixed Concrete Association," the "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau," and ASTM C94. Transit mix concrete trucks shall be equipped with an automatic device for recording the number of revolutions of the drum during the mixing period. Each mixer and agitator shall have attached thereto in a prominent place, a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades. Each mixer shall have identification number painted on the truck in such a location that it can be easily read from the batching platform.

The total volume of materials introduced into the mixer shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this subsection, the amount of materials charged into the mixer shall be reduced. The drum of the mixer shall be completely emptied of any previously mixed load. The proper proportions of aggregate, cement, and water for each load of concrete shall be placed in the mixer and shall be mixed therein for not less than 70 nor more than 100 revolutions of the drum or blades at the speed designated by the manufacturer of the equipment as the mixing speed. Additional revolutions of the drum shall be at the speed designated by the manufacturer of the equipment as the agitating speed; however, immediately prior to discharging the concrete, the drum shall be revolved at the mixing speed for a minimum of three minutes. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum.

When Class A concrete is being placed, all wash water shall be emptied from the mixer before any portion of the succeeding load is placed therein. For Class B concrete the mixer shall be empty or may carry no more than 10 gallons of water in the drum.

Water added at the point of discharge shall only take place with the approval and in the presence of the ENGINEER. Water so added shall be mixed into the load for a minimum mixing time of three minutes. Water shall not be added to the load during the transit.

The total elapsed time between the addition of water to the cement and aggregate or the addition of cement to the water and aggregate and the placement of the concrete in the forms shall not exceed 90 minutes. During hot weather or conditions contributing to quick setting, the total elapsed time permitted may be reduced at the direction of the ENGINEER to 45 minutes. When the concrete cannot be delivered to the forms within the time period specified, a water-reducing and retarding admixture may be used subject to the approval of the ENGINEER. Such use of a water reducing retarder will

be permitted only as necessary to supplement (not to replace) other acceptable hot weather procedures. The retarding admixture used shall not interfere with strength development and other properties of the concrete and its use shall be carefully controlled by the concrete supplier. Before any such admixture is permitted, it shall be tested with job site materials under job conditions to determine its compatibility with the other materials and its ability under these conditions to produce the desired properties.

Addition of water at the job site to offset evaporation of mixing water shall be done with the ENGINEER'S approval and in his presence using water in the form of a cement paste having the same water-to-cement ratio as the batch in the transit mixer. Following addition of the cement paste, the mixer drum or blades shall be rotated a minimum of 70 revolutions. Addition of water during transit to offset evaporation losses shall not be permitted.

Prolonged mixing, even at agitating speed, shall be avoided where feasible by stopping the mixer and then agitating intermittently.

A legible certified weigh master's certificate shall be prepared for each load of ready-mixed concrete. A legible copy of the certified weigh master's certificate shall be submitted to the ENGINEER by the truck operator at the time of delivery. The weigh master's certificate shall contain the following information:

1. Name of Vendor
2. Name of CONTRACTOR
3. Number of cubic yards in the load
4. Actual weights of cement and of each size of aggregate in the load
5. Amount of water added at the plant
6. Amount of free water in the aggregate
7. Brand and type of cement
8. Brand and amount of admixture
9. Time and date of batching

When mix proportions have been approved for a project and are identified by a mix number, the ENGINEER may waive the foregoing and accept a legible certified weigh master's certificate which shall contain the following information:

1. Name of Vendor
2. Name of CONTRACTOR
3. Number of cubic yards in the load

4. Mix designation number
5. Amount of water added at the plant (including free water in aggregate)
6. Time and date of batching.

Space shall be provided on the certificate so that amount of water and cement added on the job may be indicated.

3.04 CONVEYING CONCRETE

Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent separation or loss of the materials. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at the delivery end without separation of the materials.

If the concrete is to be transported more than fifty feet in carts or buggies, they shall be equipped with pneumatic tires. Concrete delivered to the carts, buggies or conveyors from spouts, troughs, or mixer trucks shall not have a free fall of more than three feet. Separation or loss of ingredients shall be prevented while transporting the concrete. Delivery carts, buggies, conveyor trucks or barrows shall be kept on temporary runways built over the floor system; runway supports shall not bear upon reinforcing steel or fresh concrete.

3.05 PLACING CONCRETE

A. GENERAL

Prior to placing concrete, the CONTRACTOR shall ensure that all reinforcement is securely and properly fastened in position and protected against displacement, that all items to be embedded in the concrete are in place and securely anchored in position, that all forms have been thoroughly coated or wetted, that all form ties at construction joints have been retightened, that concrete surfaces to be covered have had all free water, form coating, loose concrete, and debris removed, and that all conveyances, buggies, and barrows are clean and wetted.

The CONTRACTOR shall inform the ENGINEER at least 24 hours in advance of the times and places at which he intends to place concrete. The ENGINEER will make a final inspection of forms, reinforcing steel, screeds, construction joints, openings, anchors, pipe sleeves, conduit, and inserts. No concrete pour shall be started until the condition of the forms and place of pouring has been inspected and approved by the ENGINEER.

Concrete shall not be placed when the sun, wind, heat or humidity prevents proper placement and consolidation.

No water or cement shall be added to the mix without the ENGINEER'S approval or in his absence. No partially hardened concrete shall be deposited.

B. PLACING CONCRETE

Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud, dry absorbent earth or rock, or upon fills that have not been subjected to approved tamping to provide ultimate settlement.

Groundwater shall be kept below subgrade until the concrete has set. When subgrade is dry earth, it shall be thoroughly dampened with water to ensure that no moisture will be absorbed from fresh concrete.

Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent of the material passing a No. 4 sieve or where shown on the Drawings or directed by the ENGINEER, surfaces against which concrete is cast shall be covered with polyethylene film to protect the concrete from loss of water.

Joints in the film shall be lapped at least 12 inches and taped. The polyethylene film shall be protected against puncture from the underlying crushed rock by a cushion of natural or imported sand meeting the requirements of ASTM D 1073 placed on top of the crushed rock. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high pressure hose.

Place vapor barrier under designated interior concrete slabs on grade. Sheeting shall extend the full area of the slab and shall be turned up or down to footings as indicated. Lap all seams at least 12 inches and seal per manufacturer's instructions. Install reinforcement with care so as not to puncture vapor barrier. Tape all cuts, tears, punctures, and pipe penetrations before pouring concrete.

To prevent segregation of the mix, concrete shall be deposited in its final position in batches without being moved laterally in the forms more than 5 feet. A crane and a bottom dump concrete bucket shall be used wherever possible. Unless authorized by the ENGINEER, no concrete shall be dropped freely into place from a height of greater than 5 feet. Concrete shall be deposited in walls by means of prefabricated, rectangular tremies, constructed in short sections and spaced laterally not over 5 feet apart. Special care shall be observed to avoid slopping concrete over forms when placing.

The limits of each concrete pour shall be predetermined by the CONTRACTOR and shall be acceptable to the ENGINEER. All concrete within such limits shall be placed in one continuous operation.

After the concrete has been deposited, it shall be distributed over the entire area within the forms in approximately horizontal layers of not more than 18 inches in depth and shall be brought up evenly in all parts of the form. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet per hour nor more than 6 feet per hour.

Should a layer of concrete reach its initial set before the next lift can be placed or should more than 60 minutes elapse between placement of successive concrete lifts, the CONTRACTOR shall cease placement of concrete until the surface of the previous lift

is prepared in accordance with the procedures specified in Part 3.08, Construction Joints, of this specification section. Workmen shall not walk on concrete during placing or finishing with any earth or foreign matter on footgear. Hand spreading shall be done with forks and shovels, not rakes.

Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the structural system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet of vertical height. Concrete in walls or columns shall set at least two hours before concrete is placed in the structural systems to be supported by such walls or columns. Brackets, haunches and fillets shall be poured monolithic with the floor or roof slab system.

C. COMPACTION

During and immediately after placement, concrete shall be thoroughly compacted and worked into all corners and angles and around reinforcement and embedded fixtures in a manner to fill all voids, prevent honeycombing against the forms and avoid segregation of coarse aggregate. This operation shall be performed by the use of spades or forks and internal vibrators.

Vibration shall be transmitted directly to the concrete and in no case shall it be transmitted through the forms. Vibrator driving mechanisms shall revolve at not less than 7,000 rpm. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18 inches. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faces in order to secure smooth, dense surfaces. Special care shall be taken to ensure consolidation around reinforcement, pipes and other shapes built into the work. Vibrators shall be kept in motion at all times to prevent excessive vibration in one spot. The operation shall be continuous and all concrete shall be in final position before initial set has started.

In addition to the vibrators in actual use while concrete is being placed, the CONTRACTOR shall have on hand at least one operable vibrator as a spare in case of equipment failure. No concrete shall be placed until all vibrating equipment, including spares, is at the placement site.

Concrete shall be thoroughly compacted prior to top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has been compacted, the excess shall be screeded off.

D. PLACEMENT SEQUENCE

Unless otherwise indicated on the Drawings or directed by the ENGINEER, the following placement sequence shall be followed to reduce the effect of shrinkage in producing cracking:

1. BOTTOM SLAB

A center section (as outlined by the construction joints shown on the Drawings) shall be placed first. Not less than 72 hours after the center section has been placed, the Contractor may proceed with the placement of an adjoining section. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Pours shall be scheduled so that two adjacent sides of each section are free, except at closures.

2. WALLS

Walls shall be divided into sections by the construction joints shown on the Drawings. A section near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Pours shall be schedule so that one end of each section is free, except at corner closures.

3. FOOTINGS

Footings, except for wall footings, shall be poured in one operation with no joints.

E. REQUIREMENTS DUE TO ADVERSE WEATHER CONDITIONS

No concrete shall be placed during rain. No concrete shall be placed if rain is forecast unless there is sufficient time to complete the placement and finishing. All concrete placed prior to rain shall be protected by whatever means necessary to prevent damage to finish or water entering the mix. Protection equipment and materials shall be on hand prior to placement operations. Freshly placed concrete shall be protected from scour by flowing water and from mud deposits or other injurious conditions.

Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of placing shall be not less than shown in the following table for the corresponding ambient outdoor air temperature (in shade) existing at the time of placement:

Ambient Outdoor Air Temperature	Minimum Concrete Temperature
Below 35 Degrees F.	70 Degrees F.
Between 35 Degrees F. and 45 Degrees F.	60 Degrees F.
Above 45 Degrees F.	45 Degrees F.

Placing of concrete when the ambient air temperature at the time of placement is 45 Degrees F. or less shall be done only when specifically authorized by the ENGINEER using concrete heated in a manner acceptable to the ENGINEER. If the use of heated concrete is authorized, the temperature of the concrete at the time of placement shall not exceed 80 Degrees F.

Adequate means shall be provided for maintaining the temperature of the air surrounding the concrete at 70 ° F for three days, or 50 ° F for five days, or for as long as is necessary to ensure proper curing of the concrete. Rapid cooling of the concrete shall be prevented. Housing or covering or other protection used in connection with heating shall remain in place and intact at least 24 hours after the artificial heat is discontinued. The use of calcium chloride or other chemicals to prevent freezing shall not be permitted.

Except as modified herein, hot weather concreting shall comply with the requirements of ACI 305. Hot weather precautions shall be taken whenever the maximum ambient outdoor air temperature (in shade) during the day exceeds 85 Degrees F. When rapid mixing water evaporation in transit causes the concrete to be delivered in an unworkable condition, initial correction may be made at the job site, provided that water added is in the form of cement paste having the same water to cement ratio as the batch in the truck, and provided that the drum or mixer blades be operated at mixing speed for at least 70 revolutions after the paste addition. Once need for water has been observed, subsequent additions shall be at the batching plant until the need has passed. Correction shall consist of a simultaneous and proportionate increase of water and cement, up to 10 percent of the stated quantity of each material in the batch. Such increases in cement shall not constitute grounds for an increase in the Contract Price.

The temperature of concrete at the time of placement shall not exceed 85 ° F.

During hot weather, extra caution shall be taken to prevent rapid evaporation of water. Forms shall be kept cool by frequent wettings. Flat work shall be protected from drying winds, direct sun, and high temperatures whenever conditions of temperature and humidity are such as to cause plastic shrinkage cracking.

In order to prevent plastic shrinkage cracking due to rapid evaporation of moisture, no concrete shall be placed when the rate of evaporation, determined by using Figure 2.1.4 in ACI 305, equals or exceeds 0.2 pound per square foot per hour.

3.06 FINISHING

A. FINISHING FORMED SURFACES

All permanently exposed surfaces shall be expected to be smooth and of uniform texture and appearance. Surfaces to be rubbed shall include all submerged concrete surfaces that can be seen when water is drained. Rubbing may be omitted for minor blemishes on buried surfaces or on exposed surfaces that cannot normally be seen, such as inside covered tanks. Final determination for which surfaces are to be rubbed is to be the decision of the ENGINEER. All holes, pits or imperfections in the surface of the concrete shall be cleaned with a wire brush, thoroughly wetted and completely filled with damp cement mortar composed of 1 part Portland Cement to 2 parts fine aggregate. The entire surface shall be left smooth and all lines or markings shall be smoothed over to obtain uniform appearance. In the event the CONTRACTOR fails to

obtain a satisfactory appearance of the concrete in the opinion of the ENGINEER, the entire surface shall be thoroughly wetted down, kept wet continuously and rubbed with a No. 20 Carborundum stone until all lines, markings and surplus materials have been removed from the surface and until the surface shows a uniform smooth finish. After rubbing is completed, the concrete surface shall be washed clean with water. Rubbing may be done either by hand or with power tools.

B. FINISHING UNFORMED SURFACES

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating followed by troweling where required. Care shall be taken that no excess water is present when the finish is made. No special concrete or cement mortar topping course shall be used unless so shown on the Drawing.

1. SCREEDING

All slabs shall be screeded to an even surface by the use of a straight edge and screeding strips accurately and securely set to the proper level. Screeds shall be such type and so arranged so as not to interfere with the top bar reinforcement.

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch as measured from a 10-foot straight edge.

2. FLOATING

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

3. BROOMING

Surfaces of equipment bases and curbs and sidewalks shall be given a light broom finish providing a nonslip surface. Brooming shall be done after the second floating and for traffic areas shall be at right angles to the normal traffic direction.

4. TROWELING

Surfaces to be covered with resilient floor coverings and other surfaces designated on the Drawings to be troweled shall be steel trowel finished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

5. EDGING

All permanently exposed edges of unformed surfaces shall be chamfered with a 3/4 inch approved edging tool unless other edge treatment is indicated on the Drawings.

3.07 CURING

All concrete shall be protected from loss of moisture by curing for at least 14 days following placement. Curing operations shall take place immediately after concrete finishing is complete or forms are removed. Breaking of form ties or otherwise breaking the seal between the concrete surface and the form shall be considered form removal.

Curing shall be accomplished by water curing, membrane curing, film curing, or any other curing method acceptable to the ENGINEER which does not injure or discolor exposed surfaces nor destroy the bond on surfaces to receive subsequent concrete pours or protective coatings.

A. WATER CURING

Concrete surfaces being water-cured shall be kept constantly and visibly wet for a period of not less than 14 days. Water saturation of concrete surfaces shall begin as quickly as possible after the initial set of the concrete. The rate of water application shall be regulated to provide complete surface saturation with a minimum of runoff.

Slabs poured on grade and decks may be water-cured by ponding or by covering with wet burlap sacks, sand, or sawdust and keeping this covering continually and visibly wet during this period. Standard canvas seep hose placed in parallel runs on 8-foot centers is recommended for ponding.

Walls may be cured by leaving the forms tied in place and keeping the forms and all exposed surfaces of the concrete continually and visibly wet for the duration of the curing period.

B. MEMBRANE CURING

Membrane-curing compound may be used in lieu of water curing on Class B concrete and on concrete which will not be covered later with mortar, liquid hardener, or additional concrete. Except as modified herein, membrane-curing compounds shall be applied in

strict accordance with the manufacturer's recommendations. Membrane-curing compounds shall conform to the requirements of Part 2.04, Membrane Curing Compound, of this specification section.

Membrane-curing compound shall be spray applied in two separate coats, each having a surface coverage of not more than 300 square feet per gallon.

Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surface before they dry out.

Curing compound shall be suitably protected against abrasion during the curing period. Whenever the membrane will be subject to damage from traffic or other cause, it shall be protected after drying for 24 hours by a layer of sand or fine earth not less than one inch thick or by other means acceptable to the ENGINEER.

Compound applied improperly or compound applied without sufficient dye to produce a distinguishing color shall be reapplied to the satisfaction of the ENGINEER.

C. FILM CURING

Film curing with polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete or will otherwise be covered or hidden from view.

Film curing shall begin as quickly as possible after initial set of the concrete. Polyethylene sheeting shall completely cover the surfaces. Sheeting shall overlap the edges sufficiently for proper sealing and anchorage. Joints between sheets shall be overlapped a minimum of 12 inches and sealed. All tears, holes and other damage shall be promptly repaired.

Covering shall be anchored continuously at edges and shall be anchored on the surface as necessary to prevent billowing.

3.08 CONSTRUCTION JOINTS

Construction joints shall be made only at locations indicated on the Drawings or specified herein. Construction joints shall not be made at other locations without the concurrence of the ENGINEER. No vertical construction joints shall be used in walls unless specifically approved by the ENGINEER. The work shall be laid out and conducted so as to minimize the number of construction joints.

All construction joints shall be keyed. Keys shall be continuous and shall have a width equal to 1/3 of the thickness of the wall and a depth equal to 1/6 of the thickness of the wall. Unless indicated otherwise on the Drawings no keys smaller than 3 inches in width and 1-1/2 inches in depth shall be used.

Waterstops of the type specified shall be installed where indicated on the Drawings and in all construction joints in concrete walls and slabs having one face exposed in a dry pit or room and having the other face in contact with backfill, sub grade, groundwater, or other liquid.

A jet of air and water shall be applied to the surface of horizontal construction joints to remove all laitance when the concrete has set sufficiently for the jet to expose the coarse aggregate without loosening same. Immediately prior to placing another lift, the surface shall be thoroughly cleaned and washed by water jet followed by air jet to remove standing water. The surface of the concrete shall then be covered by a uniform, evenly distributed layer of cement-sand mortar to a thickness of 1 inch. The cement-sand mortar shall be composed of a mixture of 1.3 parts by volume Portland Cement and 1 part by volume fine aggregate and shall have a water-to-cement ratio equal to that of the concrete to follow.

3.09 EXPANSION JOINTS

Expansion joints shall be provided as shown on the Drawings. Details of the expansion joints and materials of construction shall be as shown on the Drawings and specified in these Contract Documents. If not shown on the Drawings, expansion joints shall consist of full-depth, preformed, 1/2-inch asphalt plank material conforming to ASTM D 994.

3.10 BONDING NEW CONCRETE TO EXISTING CONCRETE

Where new concrete is to be cast against and permanently bonded to an existing concrete surface, the existing concrete shall be chipped or cut back from the surface a minimum distance of 1-1/2 inches or as necessary to expose sound concrete, remove loose or weathered concrete and provide a roughened surface for bonding to the new concrete. Edges shall be cut square and feathered edges will not be permitted. All loose material remaining after chipping or cutting operations shall be removed by sandblasting and/or stiff wire brushing.

Where chipping back of existing concrete is not possible and where approved by the ENGINEER, the surface of existing concrete may be prepared by sandblasting or acid etching. If sandblasting or etching is used, the surface of the existing concrete shall be bare, clean, dry, and structurally sound. All grease, oil, wax, or other residue shall be removed by scraping followed by washing with a nonionic detergent or a suitable solvent compatible with the epoxy bonding agent to be used. Animal fats may be removed by scrubbing with a 10 percent solution of caustic soda to saponify them.

After all loose material, grease, etc., have been removed, the surface of the existing concrete shall be etched by either sandblasting or scrubbing with a 10-20 percent solution of hydrochloric acid in water applied at a rate of 1 quart per square yard followed by a thorough rinsing with clean water. The surface shall then be allowed to dry completely before application of the epoxy bonding agent. Goggles, rubber boots, and rubber gloves shall be worn by workmen when applying caustic soda or acids.

When the surface is dry and just prior to placing the new concrete, an epoxy bonding agent shall be applied to the surface of the existing concrete with a whitewash brush or stiff broom. The epoxy bonding agent shall be spread evenly over the surface to be bonded, avoiding skips and holidays, to wet film thickness of 40 to 60 mils. The new concrete shall be placed as soon as the epoxy bonding agent becomes tacky. In the event that the epoxy bonding agent is allowed to dry before placement of the new concrete, the surface shall be recoated with epoxy.

The epoxy bonding agent shall comply with the material requirements of Part 2.06, Epoxy Bonding Agents, of this specification section and shall be applied in strict conformance to the manufacturer's recommendations. Adequate safety precautions shall be taken during the handling and use of the epoxy bonding agent.

3.11 EMBEDDED ITEMS

Wherever steel, wrought or cast iron piping, fittings, valves, collars, sleeves, structural steel, electrical conduits, appurtenances and fixtures, equipment, anchorages or castings are shown for embedment in the concrete, such items must be on hand before concrete is poured. They shall be set in place accurately and firmly braced before concrete is poured around them. No cutouts for future installation of these items shall be permitted.

Before placing concrete, the CONTRACTOR shall see that all embedded parts are accurately positioned and firmly and securely fastened in place. They shall be thoroughly clean and free from any coating, rust, scale, oil or other foreign matter. The embedding of wood in concrete shall be avoided whenever possible. If wood is to be embedded, it shall be thoroughly wetted before the concrete is placed. After placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

Conduit shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel, conduit shall be placed under the reinforcement.

Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut and washer to be installed on the concrete side of the form or template. A second nut and washer shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

The CONTRACTOR shall be responsible for coordinating all work and ensuring that all embedded items or openings to be built into the concrete are placed in the forms before concrete is placed. The contractor shall be responsible for conferring with his subcontractors and suppliers regarding their requirements for embedments and openings.

Forms, sleeves, and inserts shall be set, and concrete shall be cast to the lines and grades indicated on the Drawings and as detailed in these Contract Documents. The maximum deviation from true line and grade shall not exceed the tolerance listed below. Deviation in alignment of slabs or wall shall not exceed a rate of 1/8 inch in 10 feet within the tolerances specified.

ITEM	MAXIMUM TOLERANCE
Sleeves and inserts	+1/8" -1/8"
Project ends of anchor bolts	+1/4" -0.0"
Anchor bolt setting	+1/16" -1/16"
Concrete forms	+1/8" -1/8"

All slabs shall be carefully finished true to grade such that the surface is free draining and contains no depressions which can hold or collect water.

Regardless of the tolerances listed herein, it shall be the responsibility of the CONTRACTOR to limit deviations in line and grade to tolerance which will permit proper installation and operation of mechanical equipment and piping.

3.12 WATER TIGHTNESS

It is the intention of this specification section to provide impervious concrete. All pits below groundwater level and all structures for holding or carrying water shall be watertight. A loss of not more than 1/4 inch depth in 24 hours will be permitted when water-holding structures are filled. All exposed surfaces of water-holding structures and interior surfaces of pits below groundwater level shall be free from visible damp spots or seepage before acceptance. Repeated tests and repairs may be required by the ENGINEER to obtain watertight structures. All structure shall be drained at the completion of tests unless otherwise directed by the ENGINEER. The cost and expense of all testing for water tightness and of providing a watertight structure shall be borne by the CONTRACTOR. Methods of repair shall be acceptable to the ENGINEER.

The use of special admixtures or integral waterproofing compounds in concrete required to be watertight is not required but may be permitted, provided the materials and methods are approved in writing by the ENGINEER.

3.13 CONCRETE EMBEDMENT AND ENCASEMENT OF PIPE

Concrete for embedment and encasement shall be installed where and as indicated on the Drawings and at such locations where installation conditions require such pipe reinforcement because of unforeseen conditions encountered in the work, as determined by the ENGINEER.

Embedment and encasement of pipe shall be preceded by the following preliminary steps:

- A. All loose material shall be removed from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.
- B. A base course of concrete shall be accurately screeded to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of such base course.
- C. Each length of pipe shall be rigidly held in alignment and anchored, to prevent flotation, in a manner acceptable to the ENGINEER.

3.14 PILE DRIVING AND CONCRETE WORK

The Contractor shall not drive foundation piling which may damage freshly placed or existing concrete structures. Minimum distance between concrete less than seven days old and pile driving operations shall be 100 feet. Any damage made to concrete structures from pile driving operations shall be repaired by the Contractor at his expense.

3.15 DEFECTIVE WORK AND METHODS OF REPAIR

All defective or damaged work shall be removed and replaced or repaired as directed by the ENGINEER. Any work which has not been constructed in accordance with these Contract Documents shall be considered defective. No defective or damaged work shall be patched, repaired or covered without prior inspection and approval of the ENGINEER.

Defects in formed concrete surfaces shall be repaired within 24 hours of placement, to the satisfaction of the ENGINEER, and defective concrete shall be replaced within 48 hours after the adjacent forms have been removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Except as modified herein, concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. All repair work shall be adequately cured.

Where authorized by the ENGINEER, repair may be accomplished by patching conducted as specified herein. However, permission to patch shall not waive the ENGINEER's right to have the defective work completely removed if the patch or repairs do not, in the ENGINEER's opinion, satisfactorily restore the quality and appearance of the work. Patching shall be conducted as follows:

- A. Chip away defective areas at least 1-1/2 inches deep perpendicular to the surface, wet the area and 6 inches around it to prevent absorption of water from patching mortar, and brush a sand-cement grout consisting of one part fine aggregate to one part Portland Cement into the surface, following with patching mortar.
- B. Patching mortar shall be no richer than one part Portland Cement to three parts fine aggregate using white Portland Cement to replace a portion of the gray cement as determined by a trial patch and shall contain only the minimum mixing water required for placing. Re-temper the mortar if necessary without the addition of water by allowing it to stand for one hour during which time it shall be mixed with a trowel to prevent setting.
- C. Mortar shall be compacted into place and screeded to leave the patch higher than the surrounding surface, then left undisturbed for one or two hours to permit initial shrinkage before being finally finished to match the adjoining surface. Cure patch in accordance with the requirements of Part 3.07, Curing, of this specification section.

3.16 LOADS APPLIED TO NEW CONCRETE

Loads including, but not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials, shall not be permitted until the concrete has reached its specified 28-day strength.

Concrete which has cracked due to overloading, loading before required strength has developed, or otherwise damaged shall be repaired or replaced as determined by the ENGINEER.

END OF SECTION

SECTION 03575
FLOWABLE CONTROLLED LOW STRENGTH MATERIAL (CLSM) FOR
ABANDONED UNDERGROUND PIPE

PART 1 – GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, equipment, and materials to pump CLSM into abandoned underground pipes as noted on the Drawings or as directed by the Engineer.

PART 2 – PRODUCTS

2.01 MATERIALS FOR CLSM

A. Materials used in this construction shall meet the following requirements:

Material	Specification
Portland Cement Type 1	AASHTO M85
Fly Ash, Class C or Class F	AASHTO M295
Water, Potable	

B. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves, shall conform to the following requirements:

Sieve Size	Total Percent Passing By Weight
¾-inch	100
No. 4	95-100
No. 16	50-90
No. 50	10-30
No. 200	0-10

2.02 PROPORTIONING FOR CLSM

A. CLSM shall be proportioned as follows:

Material	Per Cubic Yard
Portland Cement, Type 1	50 lbs. (maximum)
Fly Ash, Class C or F	250 lbs. (maximum)
Fine Aggregate	2,500 lbs.
Water	34 gals.
Cellflow Foaming Agent (or approved substitute)	3 oz. (added at the jobsite)

- B. The above proportions may be adjusted by the Engineer to obtain the consistency required for satisfactory pumping flow. Consistency shall be determined as follows:

Slump before adding foaming agent shall be 1.5-inches +/-.

Slump after adding foaming agent and mixing for at least 5 minutes and no more than 10 minutes shall be 7-inches to 9-inches.

PART 3 – EXECUTION

3.01 GENERAL

CLSM shall be used where underground pipes are to be abandoned in place.

- A. Before adding foaming agent, check initial slump. If slump meets this specification, reverse the drum and slowly move the mix to the discharge end of the drum.
- B. Pour the foaming agent directly into the mix. Run the drum forward to blend the product into the mix.
- C. **DO NOT SPRAY THE FINS.** If the foaming agent remains on the fins, bring mix to discharge end of drum several times to clean the foaming agent off.
- D. Mix at full mixing speed for 5 minutes minimum. The mix should be very fluid after mixing.
- E. Only add water **AFTER** the foaming agent has mixed for a minimum of 5 minutes. Unnecessary water is detrimental to the performance of the mix.
- F. Minimum batch for foaming agent is 3 cubic yards.
- G. Pump pipes to capacity.

END OF DOCUMENT

**SECTION 11316
SEWAGE GRINDER PUMP SYSTEMS**

PART 1 - GENERAL

1.01 SCOPE

- A. The work covered by this section includes furnishing all labor, equipment and materials required to install and test grinder pump units and polyvinyl chloride (PVC) pressure pipe and PVC gravity pipe, including pump containment basin, electrical connection, electrical control box, pipe, valves, fittings, couplings, adaptors, junction boxes, cleanouts, and accessories, as shown on the Drawings and/or specified herein.
- B. The Contractor's attention is called to the fact that all piping and accessories are not necessarily shown complete on the Drawings, which are more or less schematic. However, the Contractor shall furnish and install all piping indicated or required for proper operation of the equipment or for services requiring such piping.

1.02 QUALITY ASSURANCE

- A. All pumping equipment, pipe, valves, and fittings furnished under this section shall be new, unused, and the manufacturer's current production model. Unit must conform to the best practice known to the trade in design, quality of material, and workmanship. Assemblies, subassemblies, and component parts shall be standard and completely interchangeable. The equipment must conform with all applicable federal state, and local regulations.
- B. At the Engineer's request, the Contractor shall furnish a certificate from the manufacturer of the pipe and fittings that the manufacturer is completely competent and capable of manufacturing PVC pipe and fittings of uniform texture and strength to fully comply with these specifications and has manufactured such pipe in sufficient quantities to meet all normal construction requirements. The manufacturer must have adequate equipment and quality control facilities to be sure that such extrusion of pipe is uniform in texture, dimensions, and strength. All pipe shall be tested at the place of manufacture for all requirements of the latest ASTM and commercial Standard tests, and prior to the laying of the pipe, certified copies of the test reports covering each shipment shall be submitted to the Engineer.

Each length of pipe and each fitting shall have the following data clearly marked on each piece:

1. Nominal size
2. Type and grade of material and ASTM standard
3. SDR, Class, or schedule rating
4. Manufacturer
5. National Sanitation Foundation's seal of approval

1.03 STORAGE AND PROTECTION

A. PVC piping and accessories shall be stored and protected as follows:

1. PVC pipe and fittings shall be stored under cover.
2. All pipe and accessories shall be stored above ground and be fully supported so as not to bend or deflect excessively under its own weight. Height of stacked pipe shall not exceed 4 feet. Bundled pipe shall not be stacked more than two bundles high.
3. Kinked, flattened, buckled, broken, or otherwise defective pipe and fittings shall not be used and shall be removed from the site.
4. Pipe shall be handled using nylon slings. Wire rope slings or chains shall not be used.

B. Sewage grinder pumps shall be stored in accordance with the manufacturer's recommendations.

1.04 SHOP DRAWINGS AND ENGINEERING DATA

A. The Contractor shall submit complete shop drawings and engineering data to the Engineer in accordance with the requirements of Section 01300, "Submittals" of these Specifications.

B. Contractor shall submit complete detailed equipment, hydraulic, pneumatic, and electrical diagrams and a functional description of the completely integrated sewage pumping system, as indicated on the Drawings and described herein.

Information shall include but not be limited to:

1. Complete detailed equipment, hydraulic and control diagrams, ventilation, electrical diagrams, and specifications.
2. Dimensions of fiberglass containment basin.
3. Pump data including certified pump efficiency flow and horsepower curves.
4. Complete sectional detail drawings showing the placement of all equipment.
5. Complete and accurate plans and schematics for all electrical and mechanical equipment.
6. Clear and concise instructions for installation, alignment and adjustment of machinery.
7. Instructions for operating equipment under all design conditions.
8. Lubrication, maintenance, and trouble-shooting instructions complete with necessary diagrams and schematics.
9. Complete parts list with exploded schematics.
10. Complete wiring schematics for motors, motor controls, and other electrical components supplied with the pump systems, including interface details of the motor control system starting equipment, wet well sensing and control system, and alarm sensor.

1.05 GUARANTEE

Provide a guarantee against defective equipment, materials, and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

- A. The pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
- B. The manufacturer shall provide waterstops, acceptable to the Engineer, which shall be applied to the outside of plastic pipe when the pipe is to be enclosed in any structure where concrete or mortar is used which will prevent leakage along the outer wall of the barrel of the pipe.
- C. No single piece of pipe shall be laid on any project covered by this specification unless it is found to be generally straight. Such pipe shall have a maximum ordinate as measured from the concave side of the pipe not to exceed 1/16 inch per foot of length. If the deviation from straightness exceeds this requirement, then the particular piece of pipe shall be rejected for use until it can comply with this provision.
- D. PVC pipe shown on the Drawings to be installed outside of structures or buried underground and used to convey water or wastewater shall have push-on joints or solvent welded joints unless otherwise noted on the Drawings. All pipe material shall be Grade 1, Type 1, polyvinyl chloride (PVC) in accordance with ASTM D 1784, Class 12454-B. All pipe material shall be National Sanitation Foundation approved for use with potable water. Pipe in sizes 1-1/2 inches through 6 inches (1-1/2 inches through 12 inches for corrosive fluids) shall be SDR 21 with 200 psi pressure rating in accordance with ASTM D 2241. Pipe 1-1/4 inches in diameter shall be Schedule 40 PVC, Type 1 in accordance with ASTM D 1785 or SDR 21 when available. Maximum lengths of pipe shall not exceed 20 feet.
- E. All wyes, tees, bends, and adaptors, and any other fittings required or directed by the Engineer shall be Schedule 40 PVC with socket ends and push-on or solvent welded joints, as specified or shown on the Drawings. Fittings shall conform fully to the requirements of ASTM D 2246 in sizes ranging from 1-1/4 through 4 inches in diameter. Fittings larger than 4 inches in diameter shall be cast iron or ductile iron as specified in Section 15062 of these Specifications.

F. Joints

1. Push-On Joints

- a. The joints shall be designed so that the pipe and fittings may be connected on the job without the use of solvent cement or any special equipment. The push-on joint shall be single rubber gasket joint designed to be assembled by the positioning of a continuous, molded, rubber ring gasket in an annular recess in the pipe or fitting entering pipe into the socket thereby compressing the gasket radially to the pipe to form a positive seal. The gasket and the annular recess shall be so designed and shaped that the gasket is locked in place against displacement as the joint is assembled. Details of the joint design and assembly shall be in accordance with the joint manufacturer's standard practice. The joints shall be designed so as to provide for the thermal expansion or contraction experienced with a total temperature change of at least 75°F in each joint per length of pipe. The joint shall comply with ASTM D 3139. Gasket shall comply with ASTM F 477.
- b. Lubricant furnished for lubricating joints shall be nontoxic, shall not support the growth of bacteria, shall have no deteriorating effects on the gasket or pipe material, and shall not impart color, taste, or odor to water. The lubricant containers shall be labeled with the manufacturer's name.
- c. Gaskets shall meet all applicable requirements of ANSI A21.11. Gasket dimensions shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape as to provide an adequate compressive force against the spigot and socket after assembly to effect a positive seal under all combinations of joint and gasket tolerances. The trade name or trademark, size, mold number, gasket manufacturer's mark and year of manufacture shall be molded in the rubber on the back of the gaskets.

- d. Gaskets shall be vulcanized natural or vulcanized synthetic rubber. No reclaimed rubber shall be used. When two hardnesses of rubber are included in a gasket, the soft and hard portions shall be integrally molded and joined in a strong vulcanized bond. They shall be free of porous areas, foreign material, and visible defects. The required properties of the gasket rubber and the required method of test are given in the following table:

Property	ASTM Test Method	Main Body of Gasket	Harder Portion (if used)
Hardness, Durometer "A"	D 676 at 76±6°F	45-70	78-90
Minimum Ultimate Tensile, psi	D 412	2,000	1,200
Minimum Ultimate Elongation, Percent ¹ 125	D 412	300	
Minimum Aging, Percent ²	D 572 ³	60	60

¹Of original length

²Of original values of tensile and ultimate elongation

³Oxygen pressure method: After 96 hours at 70 ±1°C at 300 + 10 psi

- e. The gasket manufacturer shall set up such quality control procedures as will ensure the gasket's meeting the requirements of this standard. He shall furnish a monthly report of representative quality control test results to the pipe manufacturer.

- f. A sample push-on fitting shall be submitted to the Engineer for examination and approved prior to delivery of any pipe.

2. Solvent welded joints

Joints shall be made in accordance with ASTM Standard D 2672 and assembled in accordance with ASTM Standard D 2855. Furthermore, assembly shall be made in accordance with the manufacturer's

specific recommendations and appropriate safety measures taken when handling and applying solvents.

3. Threaded joints

Joints shall be made with American Standard IPS threads. All joints shall be made up with Teflon thread tape.

2.02 PVC VALVES

- A. Unless otherwise shown or required, all valves, unions, and strainers in PVC piping shall be constructed of Type 1, Grade 1 PVC. Valves shall be NSF approved and shall have a working pressure of 125 psi.
- B. Ball valves shall have double union type body, Teflon seats, Viton or EPDM seals, full diameter port, and solvent-weld ends.
- C. Check valves shall be of the ball type with union body, Viton or EPDM seat, and solvent-weld ends, as manufactured by Chemtrol Division of Celanese Piping Systems, or flapper type with weighted flapper with Buna-N seal and solvent-weld ends allowing a fully-ported opening such as manufactured by Flow Control, Inc., or equal.
- D. Valves for line sizes greater than 3 inches in diameter shall be iron body and specified in the section entitled "Valves" of these Specifications.

2.03 AIR RELEASE VALVES

- A. Air release valves shall have cast iron body, stainless steel float, and stainless steel or bronze trim.
- B. All fasteners, valve handles and nipples shall be stainless steel.
- C. Valve shall be designed for a working pressure of 0 to 150 psi.
- D. Sewage valves shall be Valve and Primer Corporation short body, "APCO 400SWA," Multiplex "Crispin Model S 20X," Val-Matic "Sewage Air Release Valve," or equal. Valves shall be equipped with an elongated

body, 2-inch NPT inlet connection, and a 1/2-inch NPT outlet connection and shall be provided with a 2-inch inlet shut-off valve, 1-inch blowoff valve, and a 1/2-inch back-flush valve with quick-disconnect coupling.

- E. All ferrous metal surfaces shall be field coated with two (2) coats, building to a total of 4.6 mils (dry film thickness) of coal tar epoxy (Glidden "Glid-Guard" Coal Tar Epoxy No. 69740, or equal).

2.04 COMBINATION AIR RELEASE AND VACUUM VALVES

Sewage valve shall be Valve and Primer Corporation short body, "APCO 400/401SWA," Multiplex "Crispin Model S 20AX," Val-Matic "Sewage Air and Vacuum Valve," or equal and shall have attachments as described for air release valve above.

2.05 METER BOXES

- A. Meter boxes in areas subject to traffic shall be of cast iron with a one-piece, heavily ribbed cast iron cover. Covers shall have the word "Sewer" cast on top, if available.

Cast iron meter boxes shall be coated inside and out with two (2) coats of a suitable bituminous coating. Cast iron meter boxes shall be similar and equal to those manufactured by John Bouchard and Sons Company of Nashville, Tennessee, or Clarksville Foundry of Clarksville, Tennessee.

- B. Meter boxes for non-traffic areas shall be a standard plastic box, constructed of high-density polyethylene. The meter box shall be fitted with a black or green lid with a key operating lid or acetal snap catch. If available, the word "Sewer" shall be impregnated in the cover.

Lid shall have a 2-1/2-inch-diameter, 16-gauge steel reflector with dichrometer coating applied to the underside of the lid for electronic detection.

Meter boxes shall be as manufactured by Davis Meter of Thomasville, Georgia, or Ametex, Plymouth Products Division.

- C. The following minimum inside dimensions are required for valves on the corresponding lines:

Line Size	Minimum Inside Dimensions Rectangular Box
1-1/4"	15-1/2" x 10-1/4"
1-1/2"	15-1/2" x 10-1/4"
2"	15-1/2" x 10-1/4"
2-1/2"	15-1/2" x 10-1/4"
3"	15-1/2" x 10-1/4"
4"*	19-7/8" x 13-1/4" C.I.
6"*	24-1/4" x 13-5/8" C.I.

*Meter boxes for check valves only. Gate valves for line sizes 4-inch and larger in diameter shall be provided with cast iron valve boxes.

- D. The Contractor shall provide and install meter boxes for each valve and cleanout where specified or shown on the Drawings. The exact field location of the meter box shall be determined by the Owner and shall be located to provide easy access to the servicemen, and not be a hazard to the customer or public, and be reasonably well protected against frost, mechanical damage and tampering.
- E. Extension shall be provided as necessary.
- F. Installation shall be performed in a neat, workmanlike manner, with the elevation of the boxes adjusted so that the lid is flush with the ground surface. Soil around the meter box shall be tamped or settled in place so that hazard is eliminated and further settling is minimized.

2.06 SEWAGE GRINDER PUMPING SYSTEMS

A. General

1. Sewage grinder pumping stations shall be factory-built automatic stations as approved by the Engineer. The manufacturer of the sewage grinder pumping stations shall have manufactured grinder pump units for a minimum of five (5) years prior to bid date of this contract.

In lieu of five (5) years prior manufacturing experience, the manufacturer shall provide a bond to the Owner to guarantee replacement of the units in the event of failure or unsatisfactory service. The period of time for which the bond is required shall be the same as the experience period of time specified. The manufacturer must have a service representative available for installation consultation during construction and on-site for a minimum of two (2) days during start-up of operation.

2. The pumping equipment must be supplied as a complete unit, and all items furnished by the manufacturer. The principal items of equipment in each pump station shall consist of a cast iron simplex or duplex grinder pump, stainless steel discharge piping, stainless steel pump mounting plates with stainless steel guide rails and hoisting chain or cable, hydraulically sealed stainless steel discharge flange, ball check valve, gate valve or ball valve, steel pump plate cover, fiberglass containment basin, mercury switch level controls, NEMA 4 junction box, NEMA 3R control panel. In addition all fasteners, clips, washers, bolts, etc. within the basin shall also be stainless steel.
3. The sewage grinder pump station shall be as manufactured by Hydr-O-Matic Pump Division of Marley Pump Company; E. F. Myers Co.; Flygt Pump Company, Division of ITT; Peabody Barnes, Inc. of Manfield, Ohio; or Ebara Pump Company, Inc. of Torrance, California.

Pump units constructed of nonmetallic materials will not be acceptable.

B. Operating Conditions

1. Grinder pumps shall be capable of operating against fluctuating total dynamic head.
2. Pump Stations (5hp) - Each pump shall be capable of delivering a minimum rate against a normal rated dynamic head as shown on Drawing No. 7. Pump motor shall be a minimum of 5 hp, single phase, 230 volt, 60 hertz, 3450 rpm (maximum). The pumps shall not overload at any point on the performance curve and shall be free from harmful effects of cavitation at either high or low head.

3. Residential Pumps - Each pump shall be capable of delivering a minimum of 8 gpm against a normal rated total dynamic head of 90 feet with a shut-off of 110 feet. Pump motor shall be a minimum of 2 hp, single phase, 230 volt, 60 hertz, 3,450 rpm (maximum). The pumps shall not overload at any point on the performance curve and shall be free from the harmful effects of cavitation at either high or low head.

C. Pumps and Motors

1. Grinder pumps and motors shall be specifically designed and manufactured to operate in a completely submerged environment in the liquid being pumped. Electrical power cord shall be sealed by use of a cord grip, with individual conductors sealed into the cord cap assembly with epoxy sealant. The cord grip shall have a male taper pipe thread threaded into a final taper pipe thread in a cord cap. The cord cap shall be sealed into the motor housing with a Buna N O-ring, providing an electrical connection that is completely watertight, yet may be easily removed from service.
2. Grinder pumps shall be of the centrifugal type with a combination impeller-grinder assembly. Pump and motor housings shall be cast iron or gray iron. The pump impeller shall be bronze or stainless steel. All fasteners shall be stainless steel.
3. The grinder assembly shall consist of a rotating cutter and a stationary cutting ring on the suction side of the impeller so the cutting assembly discharges directing into the impeller inlet. All cutters, both stationary and rotating, shall be made of hardened and ground stainless steel and shall be adjustable externally to maintain proper clearance. The upper cutter and the stationary cutting ring shall be reversible for longer service life. In the absence of reversible cutters, a spare upper cutter and cutting ring shall be furnished with each grinder pump.
4. The pump-motor shafts shall be supported by permanently oiled upper and lower bearings. Bearings and motors shall be protected from the liquid being pumped by dual mechanical seals consisting of a stationary ceramic seal and two carbon rotating sealing surfaces.

Any water leaking past the lower seal shall be detected by an electric sensing probe mounted in the seal chamber. The probe shall be connected to the alarm light in the control panel.

5. The motor winding and rotor shall be mounted in a sealed submersible type housing which is filled with clean, high-quality dielectric oil for bearing lubrication and to transmit heat from motor winding to outer housing. The motor winding shall be securely held in the housing with machine screws so that it may be removed in the field without the use of heat or a press.

An alternate design allows the use of an air-filled motor housed in a watertight container and fitted with suitable external vanes for rapid and efficient motor cooling. The motor shall be protected by a heat sensor thermostat to stop motor in the event of overheating. Thermostat shall reset automatically when the motor cools.

D. Liquid Level Controls

Pump on and off levels shall be controlled by mercury float switches. Float switches shall be hermetically sealed in a polyurethane ball. Pump on shall also be controlled by a 12-hour timer to reduce septicity in the containment basin.

Micro switches shall be activated by a magnet sealed in the housing and shall have displacement weight mounts on corrosion-proof cable with adjustable heights.

A third control switch is required to activate a red alarm light, indicating high water level in the sump or pump seal failure. For duplex pumping systems an additional control switch is required as an override to activate both pumps, and an alternator is required to regulate pump operation.

E. Containment Basin (Sump) - Residential Only

The basin shall be a minimum of 24 inches in diameter for a simplex pumping station and 30 inches in diameter for duplex systems. The height of the sump shall be as shown on the Drawings.

The sump shall be constructed of fiberglass reinforced polyester resin molded to assure a smooth interior surface. The basin walls shall be 1/4 inch thick (minimum).

The basin shall have a heavy rib or flange extended around the base on which concrete can be placed and anchored to prevent flotation.

The basin shall be fitted with a steel cover secured in place with cap screws and sealed with caulking or a rubber gasket.

Cover shall be a minimum of 3/16-inch-thick steel coated with baked enamel. No appurtenances other than cap screw shall extend above the steel cover.

The basin shall be provided with a basin inlet flange with O-ring seal or approved caulking type seal for 4-1/2-inch O.D. plastic pipe. The flange shall be mounted in the field at the inlet height required by the installation. Electrical conduit and discharge pipe shall be provided with connections as shown on the Drawings.

F. Lifting Device

Each pump basin shall be fitted with a lifting device to allow the pump to be removed from the containment basin for service without having to disconnect or disturb permanent piping or electrical connections. The lifting device shall include upper and lower guide rails with necessary supports to attach the rails to the basin.

Guide rails, guides and lifting cable shall be stainless steel of the size recommended by the manufacturer for each size pump.

G. Concrete Foundation

Each station shall have a concrete foundation formed and bolted to the base as indicated on the Drawings.

H. Electrical Control Panel

Contractor shall install, at location remote from the pumping station, a NEMA 3R waterproof enclosure on a pedestal or on the side of the building being served, as shown on the Drawings. Location of control panel shall be as close as possible to the pump station. A lock hasp shall be provided on the panel door and a red alarm light shall be mounted on the panel. A lockable, external disconnect switch shall be mounted between the customer's breaker box and the pump control panel.

A circuit breaker shall be provided for each pump along with magnetic starter, overload protection, manual reset buttons H-O-A switches, and 115-volt control circuit or a transformer to supply 24 volts for the control circuit.

Terminal strip shall be provided for connecting pump and control wires; additional terminals shall be supplied for alarm.

Float switches shall be hung in the containment basin supported by cable held to a NEMA 4 junction box.

All junction boxes shall be constructed of PVC and mounted in a manner that will allow the removal of the motor without the discharge piping hitting the junction box.

Junction box and float hanger shall be mounted within 12 inches of top of pump station.

I. Underground Conduit

1. Contractor shall connect the remote control panel with the pumping station by means of underground conduit. No additional junction boxes shall be allowed between the control panel and the NEMA 4 junction box at the pumping station.
2. Rigid metal conduit - not used.
3. Rigid nonmetallic conduit shall be installed for all conduit both above ground and underground and shall be Schedule 80 polyvinyl chloride (PVC) electrical conduit rated for 90°C. It shall be listed by Underwriters Laboratories in conformance with the National Electrical Code. The same manufacturer shall produce the conduit, the conduit fittings, the elbows, and the joint cement. Conduits shall be as manufactured by Carlon, Borg-Warner, or equal. Burial shall conform to all local codes. In the event PVC conduit is used, the Contractor shall pull a separate grounding wire from the control panel to the pump station.
4. Where conduits terminate in steel or cast NEMA 4 enclosures with no factory-installed threaded hubs, a threaded hub shall be installed equal to Myers Electric Products, Inc., Type ST or STG; Appleton Electric Company, Type HUB; Crouse-Hinds, Type HUB; or equal.

5. All conduits terminating at motor control centers shall be suitably grounded to the motor control center ground bus using grounded type insulated bushings equal to O.Z. Electrical Manufacturing Company, BLB or IGB; Appleton, Type BIB; Thomas and Betts, 3800 Series; or equal.
6. Size of conduit and conductor shall be as shown on the Drawings.

J. Conductors

1. Conductors shall be Class B concentric stranded, soft or annealed, uncoated copper free from kinks and defects in accordance with ASTM B 3 or B 8.
2. Conductors should have a conductivity not less than 97 percent.
3. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals.
4. All wires shall conform to the latest standards of the ASTM and IPCEA and shall be tested for their full length by these standards.
5. Insulation thickness shall be not less than that specified by the National Electrical Code.
6. All control circuit wiring and all wiring No. 8 AWG and larger shall be stranded. Lighting branch circuits No. 12 and No. 10 AWG may be solid. Wiring shall be stranded as follows:
 - a. No. 14 through No. 2 AWG shall have a minimum of 7 strands.
 - b. No. 1 through No. 4/0 AWG shall have a minimum of 19 strands.
 - c. No. 250 MCM through No. 500 MCM shall have a minimum of 37 strands.
7. All circuits except control and instrumentation circuits shall have a separate grounding conductor carried in the conduit.

PART 3 - EXECUTION

3.01 INSTALLATION AND TESTING OF PVC PIPE, FITTINGS, AND VALVES

- A. All provisions with respect to trenching, backfilling, bedding, and pipe laying shall conform to the applicable requirements of the section entitled "Earthwork" of these Specifications.
- B. Contractor is responsible for locating and tapping into the existing line between the house and septic tank and installing pipe from wye to the grinder pump as shown on the Drawings. Care shall be taken to maintain flow to the septic tank until the system has been approved to accept this flow.
- C. When a joint consists of a PVC flange and a metal flange, the metal flange shall be flat faced and furnished with a full face resilient gasket.
- D. PVC valves shall be installed with the flow arrow in the proper direction. Union nuts on PVC valves shall be tightened only hand tight in accordance with manufacturer's instructions. Spare O-ring seals and seats shall be furnished with each PVC valve.
- E. Where specifically shown or called for on the Drawings, service line taps into PVC pipe shall be made using tapping saddle constructed for use on PVC pipe. The saddle shall be constructed of bronze or brass, shall have all stainless steel bolts or screws, and have a resilient rubber gasket to provide a positive, watertight seal.
- F. PVC pipe laid under ground shall have a minimum of 48 inches of cover in traffic areas and 30 inches of cover in non-traffic areas.
- G. Field Testing
 - 1. After all piping has been placed and backfilled between the joints, each run of newly laid pipe, or any valved section thereof, shall be tested by the Contractor in the presence of the Engineer, and tests shall be continued until all leaks have been made tight to the satisfaction of the Engineer.

2. All piping shall be subject to a hydrostatic gauge pressure equal to the rated pressure class of the pipe being tested. The allowable leakage shall be as shown in Table 1. The duration of the test shall be a minimum of 2 hours.
3. The Contractor shall take all precautions necessary to protect any equipment that might be damaged by the pressures used in the tests. Delicate equipment shall be valved off, removed, or otherwise protected.
4. All piping shall be securely anchored and restrained against movement prior to application of test pressures. Prior to the pressure test, pipe laid in trenches shall be partially backfilled adequately to secure the pipe during the test. All joints, fittings, and valves will be left open where possible. All exposed pipe, fittings, valves, and joints shall be carefully examined during the pressure test.
5. Before applying the specified test pressure, all air shall be expelled from the pipe. If blow-offs or air release valves are not available at the high places, the Contractor shall make the necessary taps at points of highest elevation before the test is made and insert plugs after the test has been completed.
6. Any excessive leakage developing during the test shall be corrected at the Contractor's expense. If the defective portion cannot be located, the Contractor, at his expense, shall remove and reconstruct as much of the original work as necessary to obtain a facility meeting the specified leakage limits.
7. After all tests on any section have been completed to the satisfaction of the Engineer, the Contractor shall carefully clean, blow out, and drain the line of all water to prevent the freezing of the same. The Contractor shall all demonstrate to the satisfaction of the Engineer that any and all lines are free from obstructions and foreign material.
8. The Contractor shall bear the complete cost of the tests, including set-up, labor, temporary piping, blocking, gauges, bulkheads, water, air, soap solutions, and any other material required to conduct the tests.

9.

TABLE 1
ALLOWABLE LEAKAGE
U.S. Gallons per 100 Joints per Hour

Pipe Diameter (inches)	Test Pressure (psi)			
	50	100	150	200
4 or less	0.35	0.50	0.60	0.75
6	0.53	0.75	0.90	1.10
8	0.70	1.00	1.20	1.40
10*	0.88	1.25	1.50	1.75
12*	1.05	1.50	1.80	2.10

*Single-gasket coupling is one joint. Twin-gasket coupling is two joints.

3.02 INSTALLATION AND TESTING OF SEWAGE GRINDER PUMPING SYSTEMS

- A. Installation of the sewage grinder pumping system shall be in accordance with written instructions provided by the manufacturer.
- B. The manufacturer shall also provide seven copies of an operation and maintenance manual covering general operating procedures, operation, maintenance, and servicing procedures of the major individual components, and a trouble-shooting guide.
- C. The Contractor shall provide the services of a technical representative of the equipment manufacturer to supervise the final adjustments of the system, perform such operating tests as will assure the Engineer that the equipment is in proper adjustment and satisfactory operating condition, and to instruct and train the Owner's operating personnel in the use of the equipment for a minimum of one (1) day. This service shall be rendered after installation of the equipment has been completed and the entire project is ready for operation.
- D. The complete sewage grinder pumping system shall be in good working order before it is turned over to the Owner for acceptance and operation.

3.03 INSTALLATION AND TESTING OF ELECTRICAL SERVICE

- A. No existing electrical service shall be interrupted without the permission of the Owner.
- B. All equipment shall be mounted using approved bolts, anchors, and fasteners. Adhesives shall not be used to mount electrical devices.
- C. Panel boards installed against concrete or basement walls which may become damp shall be separated from the wall by 1/4-inch spacers.
- D. Installation shall be in conformance with the manufacturer's recommendations and instructions and in conformance with all local codes.
- E. After installation, circuit breakers shall be checked for proper operation and all connections checked for tightness and security.
- F. All cables and leads shall be tested for continuity and power.
- G. During construction, all installed conduits shall be temporarily plugged, capped, or otherwise protected from the entrance of dust, trash, moisture, etc., and to prevent any conduits from becoming clogged. No conductor shall be pulled in until all work that might cause damage to the conduit or conductors has been completed.
- H. Conduit straps or brackets secured to concrete, brick, or masonry shall be by means of expansion bolts, toggle bolts, or approved drill anchors. No wood plugs will be permitted.
- I. Conduits supported from building walls shall be installed with at least 1/4-inch clearance from the wall using pipe spacers equal to Appleton Electric Company, T&B Company, Steel City, or equal. Clamp back to prevent the accumulation of dirt and moisture behind the conduit.
- J. Field bending of polyvinyl chloride conduit shall be made with appropriate equipment. No torches or flame-type devices shall be used.
- K. When joints are to be made with polyvinyl chloride conduit, the conduit shall be cut with a fine-tooth saw and deburred. Conduit ends shall be wiped clean of dust, dirt, and shavings and shall be dry. A solvent cement shall be applied to bond the joint. The joint shall be watertight.

- L. Conduit shall be installed in accordance with the manufacturer's specifications and recommendations and shall conform to all local codes.
- M. After installation, conductors shall not have dents, scars, cuts, pressure indentations, abraded areas, etc.
- N. Conductors 600 volts and below shall not be bent to a radius less than 12 times the cable diameter. Conductors above 600 volts shall not be bent to a radius less than 24 times the cable diameter.
- O. Conductors may be coated with talc, soapstone, Ideal "Yellow 77" or "Wire Lube," Electro-Compound "YER-EAS," or equal, to facilitate pulling into raceways, but in no case may they be greased or coated with any substance injurious to conductor installation and strongest component of conductors, normally the metallic conductors themselves and not on the insulation jacket. When installing cable in conduit with pulling eye attached to copper conductor, the tension shall not exceed 0.008 pound per circular mil area of the conductor not 5,000 pounds, whichever is smaller. When a basket grip is used over the outer jacket of the cable, the maximum pulling tension shall not exceed 0.008 pound per circular mil area of the conductor not 1,000 pounds, whichever is smaller. In no case shall pulling tensions recommended by the wire manufacturer be exceeded. The maximum sidewall pressure exerted on the insulation and sheath at a cable bend shall not exceed 300 pounds per foot of conduit bending radius. Conductors shall not be pulled "through" any outlet, conduit or box. Separate "pulls" shall be made on each side of such point.
- P. Contractor is responsible for installation of electrical service from grinder pump to an electrical control panel, also installed by Contractor. Contractor also is responsible for providing power to the control panel from property owner's existing fuse box. All electrical work must be approved by the City's electrical inspector.

****END OF SECTION****

SECTION 15062
DUCTILE IRON PIPING AND DUCTILE IRON AND CAST IRON FITTINGS

PART 1 - GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, equipment, and materials required to furnish, install, and test ductile iron piping, including all fittings, wall pipe and sleeves, couplings, toppings, anchor blocks, and accessories, as specified herein and/or shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. The CONTRACTOR shall submit to the ENGINEER written evidence that the pipe furnished under this specification is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM or AWWA testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the ENGINEER may require that the CONTRACTOR furnish test reports from an independent testing laboratory on samples of pipe materials.
- B. Each ductile iron pipe length and fitting and cast iron fitting shall be clearly marked with the pressure rating, metal thickness class, heat mark, net weight (excluding lining or coating) and name of the manufacturer. In addition, each item of piping shall be marked with an identifying mark corresponding to the appropriate mark on the shop drawings for that particular item of piping.

1.03 SHOP DRAWINGS AND ENGINEERING DATA

- A. Complete shop drawings and engineering data on all piping and accessories shall be submitted to the ENGINEER in accordance with the requirements of the section entitled "Submittals" of these Specifications.
- B. Shop drawings shall indicate piping layout in plan and elevations as may be required and shall be completely dimensioned. The Drawings shall include a complete schedule of all pipe, fittings, specials, hangers, and supports. Special castings shall be clearly detailed showing all pertinent dimensions.
- C. The CONTRACTOR shall furnish the ENGINEER with lists, in duplicate, of all pieces of pipe and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size, and description of each item received.

1.04 STORAGE AND PROTECTION

Piping and accessories shall be stored and protected in accordance with the requirements of the section entitled "General Equipment Stipulations" of these Specifications.

1.05 SHOP PAINTING

Unless otherwise specified herein, all ductile iron pipe and fittings and cast iron fittings shall be cleaned and provided with a bituminous coating and cement lining applied at the factory.

1.06 GUARANTEE

Provide a guarantee against defective materials and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 PRODUCTS

2.01 GENERAL

- A. No broken, cracked, deformed, mishappened, imperfectly coated, or otherwise damaged or defective pipe or fittings shall be used. All such material shall be removed from the site of the work.
- B. Unless otherwise shown on the Drawings or directed by the ENGINEER and justified by specifying adequate types of bedding, the minimum pipe wall thickness and thickness class of pipe shall be as follows:

PIPE SIZE	THICKNESS CLASS	METAL WALL THICKNESS IN INCHES
3-Inch Ductile Iron	51	0.25
4-Inch Ductile Iron	51	0.26
6-Inch Ductile Iron	50	0.25
8-Inch Ductile Iron	50	0.27
10-Inch Ductile Iron	50	0.29
12-Inch Ductile Iron	50	0.31
14-Inch Ductile Iron	50	0.33
16-Inch Ductile Iron	50	0.34
18-Inch Ductile Iron	50	0.35
20-Inch Ductile Iron	50	0.36
24-Inch Ductile Iron	50	0.38
30-Inch Ductile Iron	51	0.43
36-Inch Ductile Iron	51	0.48
42-Inch Ductile Iron	51	0.53
48-Inch Ductile Iron	51	0.58
54-Inch Ductile Iron	51	0.65

2.02 DUCTILE IRON PIPE

- A. Ductile iron pipe shall be designed in accordance with ANSI A21.50, "Thickness Design of Ductile Iron Pipe", using 60,000 psi tensile strength, 42,000 psi yield strength, and 10 percent elongation.
- B. Ductile iron pipe shall be manufactured in accordance with ANSI A21.51; "Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Line Molds for Water or Other Liquids", and shall be made of ductile iron having a minimum tensile strength of 60,000 psi, a minimum yield strength of 42,000 psi and 10 percent minimum elongation.

2.03 CAST IRON AND DUCTILE IRON FITTINGS

- A. All fittings shall conform in every respect to ANSI A21.10, 2 inches through 48 inches, for Water and Other Liquids.
- B. Unless otherwise shown on the Drawings, directed or specified, all fittings shall be for pressure rating of 250 psi.
- C. In general, flanged fittings shall be ANSI pattern using long radius elbows except where space limitations prohibit the use of same. Design of all fittings, whether long or short pattern, shall be as indicated or dimensioned on the Drawings. Special fittings and cast iron and ductile iron wall pipes and sleeves shall conform to the dimensions and details shown on the Drawings.

2.04 JOINTS FOR DUCTILE IRON PIPE AND FITTINGS AND CAST IRON FITTINGS

A. GENERAL

- 1. Joints for ductile iron pipe and fittings and cast iron fittings shall be mechanical joints, flanged joints, push-on joints, or bell and spigot joints, as shown on the Drawings or specified herein.
- 2. Unless otherwise shown on the Drawings, specified or directed, all ductile iron pipe laid underground shall be joined using mechanical joints or push-on type joints.

B. MECHANICAL JOINTS

- 1. Mechanical joints shall consist of a bolt joint of the stuffing box type as detailed in ANSI A21.10 and described in ANSI A21.11.
- 2. Mechanical joints shall be thoroughly bolted in accordance with the manufacturer's recommendations with Tee Head Bolts and bolts of high

strength, heat treated cast iron containing 0.50 percent copper or high strength low-alloy steel having a minimum yield point strength of 40,000 pounds per square inch and an ultimate tensile strength of 70,000 pounds per square inch.

3. Gaskets and bolts and nuts shall conform to ANSI A21.11. Gaskets shall be of neoprene or rubber of such quality that they will not be damaged by the liquid or gases with which they will come into contact.
4. Glands for ductile iron shall be of high strength ductile iron, and glands for cast iron shall be of high strength cast iron.

C. FLANGED JOINTS

1. Flanged joints shall conform to ANSI B16.1, Class 125, and in accordance with Table 10.23 of ANSI A21.10.
2. Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolts and nuts shall conform in dimensions to the American Standard heavy series. Nuts shall be hexagonal, cold pressed. Bolts and nuts shall be cadmium plated, cold pressed, steel machine bolts, conforming to ASTM A 307, Grade B. Cadmium plating shall be by an approved process and shall be between 0.003- to 0.0005-inch thick. After each joint has been made, all bolts, heads, and nuts shall be coated with two coats of heavy asphaltum or other approved coating.
3. Gaskets of "Cranite," red rubber, asbestos composition, or other approved quality shall be used in all flanged joints. Gaskets shall conform to the requirements so of ANSI B16.21.
4. Flanged ductile iron pipe approximately twelve (12) inches or less in length shall have flanges cast solidly to the pipe barrel. Flanges on ductile iron pipe longer than (12) inches may be of the screw type. Pipe threads shall be of such length that with flanges screwed home, the end of the pipe shall project beyond the face line of the flange. Flange and pipe shall then be machined to give a flush finish to the pipe and the flange and surface shall be normal to the axis of the pipe. Ductile iron flanges shall be of such design that the flange neck completely covers the threaded portion of the pipe to protect same against corrosion. Flange faces on cast iron fittings shall be coated with white lead immediately after they have been faced and drilled. All pipe with screw type flanges shall be assembled, faced, and drilled at the point of manufacture, unless otherwise approved by the ENGINEER.
5. Where tap or stud bolts are required, flanges shall be drilled and tapped accordingly.

D. PUSH-ON JOINTS

1. Push -on joints shall conform to ANSI A21.11. Details of the joint design shall be in accordance with the manufacturer's standard practice such as "Fastite," "Bell-Tite," or "Tyton" joints.
2. Gaskets shall be in accordance with ANSI A21.11 and shall be of such quality that they will not be damaged by the liquid or gases with which they will come into contact.

2.05 PIPE COATING AND LINING

- A. All ductile iron pipe and fittings and cast iron fittings buried underground or submerged shall have a standard bituminous outside coating conforming to ANSI A21.6 or A21.51. All exposed ductile iron pipe and ductile iron and cast iron fittings shall have an outside coating of universal primer.
- B. All ductile iron pipe used for water or Wastewater shall have cement mortar lining of standard thickness in accordance with ANSI A21.4. Cement mortar lining for cast iron and ductile iron fittings shall be double the standard thickness under ANSI A21.4
- C. No lining shall be provided for ductile iron pipe and ductile iron and cast iron fittings used for air.
- D. Where a special lining is indicated on the Drawings for resistance to corrosive wastewaters, pipe and fittings shall be furnished with a minimum 20 mil thick lining of chemically inert, abrasion resistant polyethylene. The lining shall be a blend of high density and low density polyethylene powders complying with ASTM D 1248 compounded with carbon black to provide resistance to ultraviolet rays during storage above ground. The pipe shall be preheated in a furnace (to ensure uniformity of heat distribution) to an adequate temperature to provide uniform fusing of the polyethylene powders and proper bonding to the pipe. The lining shall be unaffected by hydrogen sulfide, detergents, grease, oil, inorganic acid, alkalis, and most organic materials found in municipal wastewaters and shall be suitable for service at operating temperatures of up to 180 degrees F. The lining shall have a Hazen-Williams "C" coefficient of approximately 150 and a Manning "n" coefficient of approximately 0.010. Polyethylene- lined ductile iron pipe shall be U.S. Pipe "Polylined," American Cast Iron Pipe "Polybond," or equal.

2.06 PIPE COUPLINGS

- A. Pipe couplings shall be installed where shown on the Drawings, required for installation, or directed by the ENGINEER.
- B. Pipe couplings shall conform to the requirements of the section entitled "Pipe Couplings and Expansion Joints" of these Specifications.

2.07 WALL PIPE AND WALL SLEEVES

- A. CONTRACTOR shall furnish and install ductile iron wall pipe or wall sleeves where ductile iron piping connects with or passes through concrete walls or floors and in locations where small piping and electric wiring and conduits connect with or pass through concrete walls or floors.
- B. Where wall pipes or sleeves are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

2.08 SPARE PARTS

The CONTRACTOR shall furnish four (4) spare gaskets for each size and type of joint requiring the use of a gasket. The CONTRACTOR shall furnish eight (8) bolts and nuts of each size and type used for cast iron and ductile iron pipe joints.

PART 3 EXECUTION

3.01 LAYING

- A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Great care shall be taken to prevent the pipe coating from being damaged, particularly cement lining on the inside of the pipes and fittings. Any damage shall be remedied as directed by the ENGINEER.
- B. All pipe and fittings shall be carefully examined by the CONTRACTOR for defects just before laying and no pipe or fitting shall be laid which is defective. If any defective pipe or fitting is discovered after having been laid, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the CONTRACTOR at his own expense.
- C. All pipes and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.
- D. Pipe laid in trenches shall be laid true to line and grade on a firm and even bearing for its full length at depths and grades as shown on the Drawings. Adequate precautions shall be taken to prevent flotation of pipelines prior to backfilling. Installation of ductile iron pipe in underground pressure piping systems shall conform to the requirements of AWWA C600. Excavation of trenches and backfilling around pipes shall conform to the requirements of the section entitled "Earthwork" of these Specifications.

- E. All ductile iron piping laid underground shall have a minimum of 36 inches of cover above the top of the pipe unless otherwise shown on the Drawings.
- F. All elbows, tees, branches, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust. Underground pressure piping containing unharnessed push-on or mechanical joints or expansion joints shall be restrained by thrust blocks. Thrust blocks shall consist of Class B concrete conforming to the requirements of the section entitled "Cast-In-Place Concrete" of these Specifications and shall be of the size and shape as shown on the Drawings. The CONTRACTOR may use forms or earth walls to mold the thrust blocks. When earth walls are used, they shall be cut true to shape and all excess earth removed. The work shall be conducted so that no loose earth will become mixed with the concrete. At the end of 24 hours, damp earth may be placed over the concrete to retain moisture.
- G. All ductile iron pipes entering buildings or basins shall be adequately supported between the structure and undisturbed earth as shown on the Drawings to prevent breakage resulting from settlement of backfill around the structure.
- H. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and wall sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed.
- I. Wall pipe and wall sleeves shall be installed when the wall or slab is constructed. Blocking out or breaking of the wall for later insertion shall not be permitted.
- J. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.
- K. Sufficient couplings and flanged joints shall be provided to facilitate equipment installation and removal.
- L. Exposed ductile iron piping shall be supported as shown on the Drawings and specified in the section entitled "Pipe Supports and Hangers" of these Specifications.

3.02 CUTTING

- A. Whenever pipe requires cutting to fit the lines, the work shall be done in such manner as to leave a smooth end at right angles to the axis of the pipe. When a piece of pipe is cut to fit into the line, no payment will be made for the portion cut off and not used.
- B. Whenever existing pipe requires cutting to install new fittings, the work shall be done in such manner as to leave a smooth end at right angles to the axis of the pipe and special care shall be exercised to guard against breaking or splitting the existing piping.

- C. All cutting of ductile iron pipe shall be done with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipe

3.03 JOINING

A. MECHANICAL JOINTS

1. The successful operation of the mechanical joint specified require that the spigot be centrally located in the bell and that adequate anchorage shall be provided where abrupt changes in direction and dead ends occur.
2. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.
3. Joint bolts shall be tightened by the use of approved wrenches to a tension recommended by the pipe manufacturer. When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This may be done by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side and last, the remaining bolts. This cycle shall be repeated until all bolts are within the range of acceptable torque. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.
4. After installation, bolts and nut in buried or submerged piping shall be given two (2) heavy coats of bituminous paint.

B. FLANGED JOINTS

1. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by cross over sequence. Where screwed flanges are used, the finished pip edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.
2. Connections to equipment shall be made in such a way that no strain is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.

3. After installation, bolts and nuts in buried or submerged piping shall be given two (2) heavy coats of a bituminous paint.

C. PUSH-ON JOINTS

1. The inside of the bell and the outside of the pipe from the plain end to the guide stripe must be wiped clean immediately before assembling the pipe joint. Then the rubber gasket shall be inserted into a groove or shaped recess in the bell. Both the bell and spigot ends to be joined shall be wiped again to ensure they are thoroughly clean. A liberal coating of special lubricant furnished by the pipe manufacturer shall be applied to the outside of the pipe from the plain end to the yellow guide stripe and to the inside of the gasket. The plain end shall be centered in the bell and the spigot pushed home. Wherever possible the pipe shall be socketed by hand; however, jacking may be required to push the spigot in place on the larger sizes of pipe. The completed joint shall be permanently sealed and watertight.
2. Whenever the pipe is cut in the field, the cut end shall be conditioned so it can be used in making up a joint by filing or grinding the cut end to remove burrs or sharp edges that might damage the gasket.

D. PERMISSIBLE DEFLECTION OF JOINTS

1. Deflection of ductile iron pipe at joints for long radius curves or for avoiding obstacles shall be permitted only upon approval of the ENGINEER.
2. Where deflection of joints is permitted, such deflection shall be made in accordance with and shall not exceed limits provided in Section 9b.5 and Section 9c.4 as applicable, of AWWA C600.

E. JOINTS OF DISSIMILAR METALS

When a flanged joint consists of a ductile iron flange mated to a steel or alloy flange, the steel flanges shall be flat-faced and furnished with full-faced gaskets, insulating bushings, and stainless steel bolts.

3.04 SERVICE CONNECTIONS

- A. In general and unless otherwise shown, small service lines and branches shall connect to larger cast iron or ductile iron mains using cast iron tapped tees and crosses.
- B. Tapped tees and crosses shall have minimum 2-inch NPT branch connections and shall be furnished with mechanical joint ends.

3.05 CUT-INS TO EXISTING PIPING

- A. In general and unless otherwise shown, cut-ins to existing ductile iron piping for installation of new mechanical joint fittings and valves shall be made using ductile iron cutting-in sleeves.
- B. Cutting-in sleeves shall have a pressure rating not less than that of the existing pipeline and shall be furnished with a mechanical joint end on one end and a plain end on the other.

3.06 DRILLING AND TAPPING

- A. Wherever required ductile iron pipe and fittings and cast iron pipe and fittings shall be drilled and tapped to receive drainage or any other piping. All holes shall be drilled accurately at right angles to the axis of any pipe or fitting. Where plugs are drilled, holes shall be at right angles to the face of the plug.
- B. Where the size of the pipe to be connected is such as to require bosses for connections and when the pipe wall thickness is too thin to permit the effective length of pipe threads to be utilized as necessary for the size pipe being connected by threads, the CONTRACTOR shall furnish such pipe with cast-on bosses suitable for drilling, tapping, and connecting such pipe. Alternately, where shown or specified a tapped saddle clamp may be used in lieu of a cast-on boss. Saddle clamp shall be of the heavy-duty type with O-ring gaskets and two heavy U-bolt clamps.
- C. All tapping shall be carefully and neatly done by skilled workmen with suitable tools.
- D. Where connections are made between new and old piping, the connection shall be made in a thorough and workmanlike manner using proper fittings and specials to suit actual conditions.
- E. Cut-ins to existing and operating pipelines shall be done at times agreeable to the Owner upon approval of the ENGINEER.
- F. Existing pipelines that may be cut or damaged during the performance of work under this item shall be repaired, reconnected, and returned to service in equal or better condition in which they were found and in accordance with the requirements of this Specification.
- G. No separate payment will be made for drilling, tapping, making connections, cut-ins, repairs to damaged existing pipelines, and reconnections in existing pipelines.

3.07 FIELD TESTING-PRESSURE PIPING

- A. After all piping has been placed and backfilled between the joints, each run of newly laid pipe, or any valved section thereof, shall be tested by the CONTRACTOR in the presence of the ENGINEER, and tests shall be continued until all leaks have been made tight to the satisfaction of the ENGINEER.
- B. All pressure piping shall be subject to a hydrostatic gauge pressure equal to 150 percent of the maximum operating pressure of the pipe section under test or 150 psig, whichever is greater, based on the elevation of the lowest point of the section of pipe under test and corrected to the elevation of the test gauge. The above pressures shall be maintained for a minimum of two consecutive hours. No leakage will be allowed. Leakage may be determined by losses of pressure or other methods approved by the ENGINEER.
- C. The CONTRACTOR shall take all precautions necessary to protect any equipment that might be damaged by the pressures used in the tests. Delicate equipment shall be valved off, removed, or otherwise protected.
- D. All piping shall be securely anchored and restrained against movement prior to application of test pressures. Prior to the pressure test, pipe laid in trenches shall be partially backfilled adequately to secure the pipe during the test. All joints, fittings and valves will be left open where possible. All exposed pipe, fittings, valves, and joints shall be carefully examined during the pressure test.
- E. Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants, blow-offs, or air release valves are not available at the high places, the CONTRACTOR shall make the necessary taps at points of highest elevation before the test is made and insert plugs after the test has been completed.
- F. After satisfactory completion of the pressure test, a leakage test shall be performed on each section of pipe in accordance with Section 4.2 of AWWA C600 at a hydrostatic pressure equal to the maximum operating pressure of the pipe section under test, based on the elevation of the lowest point of the line or lowest point of the section under test and corrected to the elevation of the gauge.
- G. Any leakage developing during the test shall be corrected at the CONTRACTOR'S expense by tightening, replacing packing or gaskets, or replacing defective portions of the piping system. Caulking will not be permitted. If the defective portion cannot be located, the CONTRACTOR, at his expense, shall remove and reconstruct as much of the original work as necessary to obtain a facility tested without leakage.
- H. After all tests on any section have been completed to the satisfaction of the ENGINEER, the CONTRACTOR shall carefully clean, blow out, and drain the line of all water to prevent the freezing of the same. The CONTRACTOR shall also demonstrate to the satisfaction of the ENGINEER that any and all lines are free from obstructions and foreign material.

- I. The CONTRACTOR shall bear the complete cost of the tests, including set-up, labor, temporary piping, blocking, gauges, bulkheads, water, air, soap solutions, and any other materials required to conduct the tests.

3.08 FIELD TESTING - GRAVITY PIPING

- A. After completion of any section of sewer, the grades, joints, and alignment shall be true to line and grade. Joint surfaces shall be smooth. There shall be no visual leakage and the sewer shall be completely free from any cracks and from protruding joint materials, deposits of sand, mortar, or other materials on the inside.
- B. Infiltration shall not exceed 25 gallons per 24 hours per inch of diameter per mile of sewer. Contractor shall furnish all supplies, materials, labor, services, etc., needed to make infiltration or exfiltration tests including water. No separate payment will be made for equipment, supplies, material, water, or services.
- C. Any leakage, including active seepage, shall be corrected by removal and replacement of pipe or joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.
- D. The sewers installed under this contract will be subject to television inspection by the Owner and/or Engineer. It is the intent to televise all sewers which are suspected to contain defects in order to insure that all installation is water tight. The Owner reserves the right to perform this work and will furnish all equipment and materials for such inspection. Otherwise the Contractor will cause to have the television work performed.
- E. If the television work is performed by the Owner, the Contractor shall provide access for the Owner's crews and equipment for the television inspection and shall have his representative present during inspection.
- F. The television work, if performed by the Owner, shall be scheduled so as to take advantage of the time when the groundwater table is most likely to cause infiltration. Work shall be scheduled during or after rainy periods rather than after prolonged periods of dry weather. Logs and/or tapes of the inspections will be made available to the Contractor. Otherwise, the Contractor shall perform the work and furnish tapes and logs to the Owner and the Engineer.
- G. All sewer pipe shall be tested using low pressure air testing in accordance with the procedures and standards listed below.
 1. Clean pipe to be tested by propelling a snug-fitting inflated rubber ball through pipe with water.
 2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, pressurizing equipment shall include a regulator set at slightly above test pressure to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.

3. A plug shall be installed in one end of the pipe to be tested. A second plug with a 1/2" opening to allow for the introduction of air into the portion of pipe to be tested shall be put in place in the other end of the pipe.
4. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any groundwater above the pipe (0.43 psi per foot of groundwater above the pipe invert), but not greater than 9.0 psig.
5. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
6. When pressure decreases to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 3.0 psig. Minimum permissible pressure holding times for runs of single pipe diameter are indicated in the table in seconds. No separate allowance shall be given for laterals.

**TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED**

Pipe Dia. (in)	Min. Time (min: sec)	Length for Min. time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	
15	7:05	159		7:05	7:05	8:54	11:08	13:21	15:35			
18	8:30	133		8:30	9:37	12:49	16:01	19:14	22:26	25:38		
21	9:55	114		9:55	13:05	17:27	21:49	26:11	30:32	34:54		
24	11:20	99	6.837xL	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	
27	12:45	88	8.653xL	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	
30	14:10	80	10.683xL	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	
33	15:35	72	12.926xL	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57	
36	17:00	66	15.384xL	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23	
42	19:74	57	20.942xL	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04	
48	22:67	50	27.352xL	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09	

END OF DOCUMENT

SECTION 15064-B
POLYVINYL CHLORIDE (PVC) SEWER AND SERVICE PIPE

PART 1 - GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, equipment, and materials required to install and test polyvinyl chloride (PVC) pipe, including accessories, as shown on the Drawings and/or specified herein.

1.02 QUALITY ASSURANCE

- A. The Contractor, at the Engineer's request, shall furnish a certificate from the manufacturer of the pipe and fittings that the manufacturer is fully competent and capable of manufacturing PVC sewer pipe, fittings, and accessories of uniform texture and strength that will fully comply with these Specifications and have so manufactured this class of pipe in sufficient quantities to be certain that it will meet all normal field conditions of usage. The manufacturer must have adequate equipment and quality control facilities to be sure that each extrusion of pipe is uniform in texture, dimensions, and strength.
- B. Pipe shall be tested when requested by the Engineer and all pipe so designated shall be tested in accordance with ASTM D 2412 "Standard Method of Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading."
- C. Each length of pipe and each fitting shall have the following data clearly marked on each piece:
 - 1. Manufacturer's name
 - 2. Pipe size
 - 3. PVC compound used
 - 4. ASTM material specification for the PVC compound used

1.03 SHOP DRAWINGS AND ENGINEERING DATA

Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.04 STORAGE AND PROTECTION

- A. PVC piping and accessories shall be stored and protected in accordance with the requirements of the section entitled "Storage and Protection" of these Specifications.

- B. PVC pipe and fittings shall be stored under black plastic cover.
- C. All pipe and accessories shall be stored above ground and fully supported so as not to bend or deflect excessively under its own weight.

1.05 GUARANTEE

The Contractor shall provide a guarantee against defective equipment and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

- A. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
- B. The manufacturer shall provide waterstops, acceptable to the Engineer, which shall be applied to the outside of the plastic pipe when the pipe is to be enclosed in any structure where concrete or mortar is used which will prevent leakage along the outer wall of the barrel of the pipe.
- C. No single piece of pipe shall be laid on any project covered by this Specification unless it is found to be generally straight. Such pipe shall have a maximum ordinate as measured from the concave side of the pipe not to exceed 1/16 inch per foot of length. If the deviation exceeds this requirement, then the particular piece of pipe shall be rejected from use until it can comply with this provision.
- D. Wyes, tees, bends, adapters, and any other fittings required or directed by the Engineer shall be provided. Engineering data for such fittings showing cross-sectional views with dimensions shall be provided and such data and fittings shall be approved by the Engineer prior to their use. The materials used in the manufacture of fittings shall conform to the requirements for the pipe with which they shall be used and any variation of such requirements shall be subject to the approval of the Engineer. Fittings shall have wall thicknesses equal to or greater than that of the pipe to which they are joined.

2.02 PIPE

- A. The 4-inch through 15-inch PVC pipe and accessories shall be manufactured in accordance with the requirements of either ASTM D3034, Type PSM (SDR 35 or less) or ASTM F789, Type PS-46 POLY (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings. The 18-inch through 36-inch PVC pipe and accessories shall be manufactured in accordance with the requirements of ASTM F679, Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

- B. The standard length of PVC pipe under this Specification shall be 20 feet with a minimum of 10 feet, except that all pipe used in service lines shall not exceed 10 feet in length unless otherwise approved by the Engineer.

2.03 JOINTS

- A. PVC pipe joints shall be the bell and spigot type subject to the approval of the Engineer.
- B. The pipe joint shall meet ASTM D-3212-81 for joints for drain and sewer pipes using flexible elastomeric seals, and the seals shall meet ASTM F-477 for elastomeric seals. All gaskets shall be factory installed and positively retained by means of a steel, polypropylene, or PVC ring.

Factory-installed glued gaskets will be acceptable; however, field-installed gaskets will not be acceptable for ASTM D-3034, ASTM F789, or ASTM F-679 PVC pipe. Pipe manufactured according to ASTM F949 is permitted to have a field-installed gasket.

PART 3 - EXECUTION

3.01 PIPE LAYING

- A. Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared and bracing and sheeting installed where required. A mason's line, supported at intervals not exceeding 50 feet, shall be stretched tightly above ground level at a grade parallel to and directly above the axis line of the pipe. Each pipe shall be accurately placed to the exact line and grade called for on the Drawings by measuring down from this line to the invert of the pipe in place. The Contractor shall furnish all labor and materials necessary for erecting batter boards and establishing lines and grades therefor.
- B. The Contractor may use the laser beam method of setting a line and grade for the sewer by using the laser beam coaxially through the center of the sewer being laid. The laser beam projector is to be rigidly mounted to its support platforms, with a two-point suspension, or equivalent, assuring that all ground and equipment vibrations are kept to an absolute minimum. All equipment including equipment necessary to control atmospheric conditions in the pipe to keep line and grade to acceptable standards of accuracy shall be furnished by the Contractor. The laser beam system must be operated by competent experienced men who have been properly trained to operate the equipment used.
- C. The Contractor shall stake check pegs at all manholes throughout the job. Check pegs midway between manholes and any other check points deemed necessary to assure accuracy of the equipment shall be provided by the Contractor.
- D. The Contractor shall stake check pegs at all manholes throughout the job. Check pegs midway between manholes and any other check points deemed necessary to assure accuracy of the equipment shall be provided by the Contractor.

- E. Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill. No pipe shall be laid except in the presence of an inspector representing the Engineer. Trench bottoms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with approved compacted materials.
- F. Bell holes shall be of sufficient size to allow ample room for making the pipe joints properly. Bell holes shall not be cut out more than ten joints ahead of pipe laying. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length as shown on the Drawings. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe in order to avoid sudden offsets or inequalities in the flow line.
- G. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completely set or before the trench has been backfilled. The Contractor at no time shall open up more trench than his available pumping facilities are able to dewater. Where sewer pipelines are located in or across stream beds or drainage ditches, the Contractor shall divert the stream flow and dewater each section as the work progresses.
- H. No joints shall be made where pipe or joint material have been soiled by earth in handling until such soiled surfaces are thoroughly cleaned by wire brushing and wiping until all traces of the earth are removed.
- I. As the work progresses, the interior of all pipe shall be kept thoroughly clean. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior. A filled bag or other approved type of follower shall be pulled through the line immediately after each joint is made in order to remove any debris which may be left on the inside of the pipe.
- J. Backfilling of trenches shall be started immediately after the pipe in place has been inspected and approved by the Engineer and backfill shall be deposited and compacted as provided under the section entitled "Earthwork" of these Specifications.
- K. Installation of service pipe shall conform to the appropriate requirements of main line sewers.
- L. Connections of service lines to the main sewer shall be made with bends of the proper degree to make the service run perpendicular to the main sewer. Pipe shall be laid to a uniform line and grade. Minimum grade shall be 1 percent.
- M. Connections of service lines to the main sewer shall be made with bends of the proper degree to make the service run perpendicular to the main sewer. Pipe shall be laid to a uniform line and grade. Minimum grade shall be 1 percent.
- N. The end of all service connections shall be plugged with a PVC plug and sealed with plastic joint material.

- O. Crushed stone bedding and backfill material, concrete encasement and protection, etc., for service line installation shall be provided as conditions require and as directed by the Engineer.
- P. No service connections shall be covered until they have been inspected and located by the Engineer.

3.02 INSTALLATION OF TEES, RISERS, AND PLUGGED STUBS

- A. Tee branches shall be installed in the sewer lines at all places shown on the Drawings, specified herein or otherwise directed by the Engineer. Tee branches on pipe less than 12 inches in diameter shall be cast or extruded and manufactured monolithic with the barrel.
- B. Riser connections of the size and type shown on the Drawings shall be installed at the locations shown on the Drawings or directed by the Engineer. A plastic film marking tape 5-feet long shall be placed 12 inches over the top of each riser during backfilling to mark the location of the riser. The marking tape shall be heavy gauge polyethylene film (.004-inch thick). Tape shall be standard red color imprinted with the words "Warning-Buried Sewer Line Below." Tape shall be Allen Marking Tape No. AMT-1212 as manufactured by the Allen System Inc., Glen Ellyn, Illinois, or equal. A second marking tape containing a metallic core which can be located with a metal detector shall be laid on top of the first marking tape. This tape shall be 5 feet long and 3 inches wide. Tape shall be Allen Detectotape Catalogue No. ADT-1003 for buried sewer line as manufactured by the Allen System Inc., or equal.
- C. Plugged pipe stubs for future connections to manholes and sewerage structures shall be installed where shown on the Drawings or directed by the Engineer. The pipe stubs shall be installed with the bell encased in the wall of the manhole and the bell opening flush with the outside wall of the manhole or structure. Stubouts shall be the type manufactured by McCullough Industries or an approved equal.
- D. Plugged stubs and such branches of pipelines that are not to be used immediately shall be closed with PVC stoppers held securely in place.
- E. Where specifically directed by the Engineer or shown on the Drawings, connections to reinforced concrete pipe over 18 inches in diameter shall be made in accordance with details shown on the Drawings.

3.03 CONNECTIONS

- A. If the work consists of the construction of a sewer that is to replace an existing sewer, all of the existing service lines shall be kept in operation and connected to the new line.
- B. Connections shall be made to all existing sewer lines in the vicinity of the work by removing a section of the sewer from the existing line and inserting in the space a tee branch of proper size, or by the construction of a manhole, regulator chamber or other structure as shown on the Drawings.

- C. Connections to existing manholes or inlets where no plugged stubs exist shall be made by cutting a hole in the wall of the existing structure, installing a Kor-N-Seal rubber boot, inserting a length of sewer pipe into the hole, filling around same with concrete or mortar and troweling the inside and outside surfaces of the joint to a neat finish. The bottom of the manhole shall be shaped to fit the invert of the sewer pipe as specified under the section entitled "Manholes" of these Specifications.
- D. Connections to building services shall be made in a neat and workmanlike manner. Cleanout plugs shall be installed, wherever feasible, by making the connections with a standard wye or tee.

3.04 EXISTING UTILITIES

- A. All existing sewers, water lines, gas lines, underground conduits, telephone lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work shall be carefully protected by the Contractor from damage at all times. Where it is necessary for the proper accomplishment of the work to repair, remove and/or replace any such utility, the work shall be done under the provisions set forth in the "General Conditions." No Separate payment shall be made for removing and replacing and/or repairing damaged existing sewers; water, gas, electric, telephone lines or conduits; or other utilities, culverts, drains, or conduits or similar existing services or structures. Similar repair and replacement of sidewalks, curbs, gutters, and pavements are provided elsewhere in these Specifications.
- B. Sewers to be installed parallel to any existing or proposed water main shall be laid at least 10 feet, horizontally, from the water main. If conditions prevent the 10-foot separation, the sewer may be constructed closer to a water main if it is laid in a separate trench and if the bottom of the water main at least 18 inches above the top of the sewer.
- C. When sewers cross under water mains, the top of the sewer shall be at least 18 inches below the bottom of the water main. If necessary, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint ductile iron pipe for a distance of 10 feet on each side of the sewer. One full length of water main shall be centered over the sewer so that both joints will be as far from the sewer as possible.
- D. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both water main and sewer shall be constructed of mechanical-joint ductile iron pipe and shall be pressure tested to assure water tightness.
- E. When sewer lines cross under culverts where the sewer and the culvert are less than 18 inches apart, the sewer line shall be encased in concrete as shown on the Standard Drawings.

3.05 INSPECTION AND TESTING

- A. The grade, joints, and alignment shall be true to line and grade after completion of any section of sewer. Joint surfaces shall be smooth. There shall be no visual leakage and the sewer shall be completely free from any cracks and from protruding joint materials, deposits of sand, mortar, or other materials on the inside.
- B. One hundred percent of all PVC pipe 8 inches in diameter and greater shall be deflection tested. The maximum allowable deflection for PVC pipe is 5 percent. After the PVC pipe has been installed and backfilled, the Contractor shall check the deflection by pulling a rigid ball or an Engineer approved 9-arm mandrel sized at 95 percent of the actual inside diameter of the pipe used through the pipe. Deflection tests shall not be conducted before the elapse of 30 days after backfilling. Any pipe not passing the mandrel shall be replaced and rechecked.
- C. Infiltration shall not exceed 25 gallons per 24 hours per inch of diameter per mile of sewer. Contractor shall furnish all supplies, materials, labor, service, etc., needed to make infiltration or exfiltration tests including water. No separate payment will be made for equipment, supplies, material, water, or services.
- D. Any leakage, including active seepage, shall be corrected by removal and replacement of pipe or joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.
- E. The sewers installed under this contract will be subject to television inspection in accordance with Section 02752 of these specifications.
- F. The Contractor shall provide access for the Owner's crews and equipment for the television inspection and shall have his representative present during inspection.
- G. The television work shall be scheduled so as to take advantage of the time when the groundwater table is most likely to cause infiltration. Work shall be scheduled during or after rainy periods rather than after prolonged periods of dry weather. Logs and/or tapes of the inspections will be made available to the Contractor.
- H. All sewer pipe shall be tested using low pressure air testing in accordance with the procedures and standards listed below.
 - 1. Clean pipe to be tested by propelling a snug-fitting inflated rubber ball through pipe with water.
 - 2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, pressurizing equipment shall include a regulator set at slightly above test pressure to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.

3. Add air slowly to the portion to the pipe installation under test until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any groundwater above the pipe (0.43 psi per foot of groundwater above the pipe invert), but not greater than 9.0 psig.
4. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
5. When pressure decreased to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 3.0 psig. Minimum permissible holding times for runs of single pipe diameter are indicated in the table in seconds. No separate allowance shall be given for laterals.

**TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED**

Pipe Dia. (in)	Min. Time (min: sec)	Length for Min. time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
15	7:05	159		7:05	7:05	8:54	11:08	13:21	15:35		
18	8:30	133		8:30	9:37	12:49	16:01	19:14	22:26	25:38	
21	9:55	114		9:55	13:05	17:27	21:49	26:11	30:32	34:54	
24	11:20	99	6.837xL	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653xL	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683xL	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926xL	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384xL	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:74	57	20.942xL	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	22:67	50	27.352xL	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09

3.06 CLEANUP

After completing each section of the sewer line, the Contractor shall remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line and leave the entire right-of-way in a clean and neat conditions. Unless otherwise called for on the Drawings, the Contractor shall restore all disturbed areas to as close to its original condition as possible. Restoration shall include but not be limited to grassing, replacing shrubbery, trees, fences and other improvements which have been disturbed.

Cleanup and restoration shall be complete within 60 calendar days after each section of sewer line is installed. Should the Contractor fail to do the cleanup within 60 calendar days, payment made for pipe sewers and service lines for that section of the sewer not cleaned up shall be removed from the periodic estimate until the cleanup work is completed.

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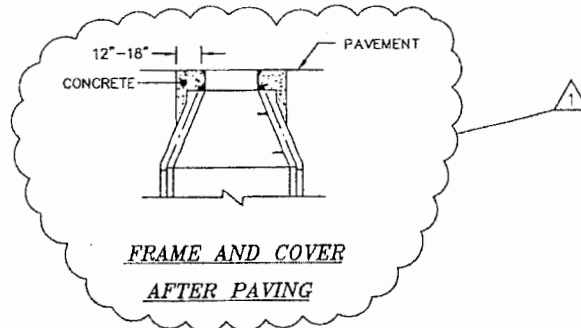
APPENDIX C
STANDARD DETAILS FOR SANITARY SEWERS

APPENDIX C
STANDARD DETAILS FOR SANITARY SEWERS

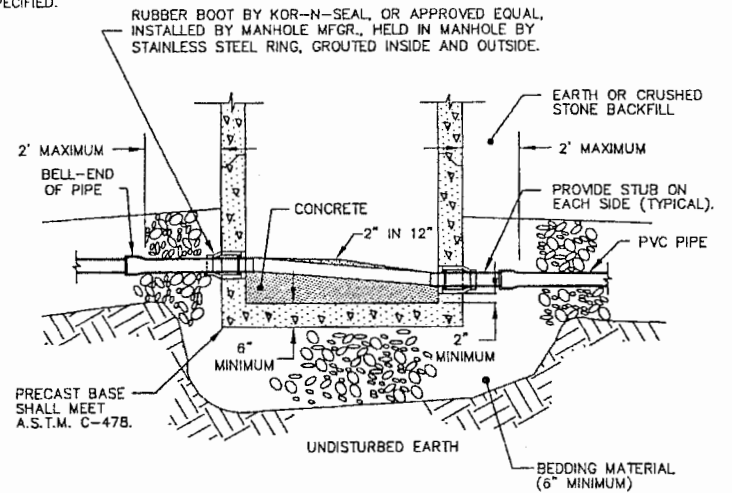
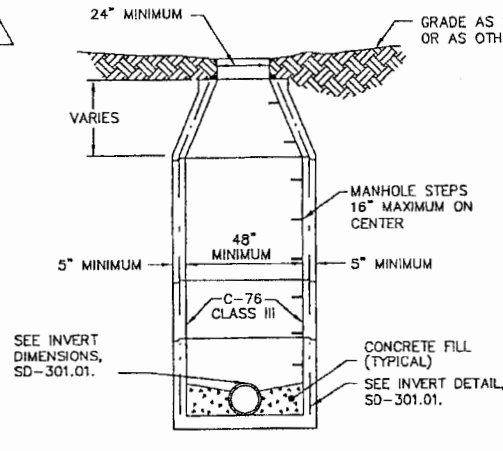
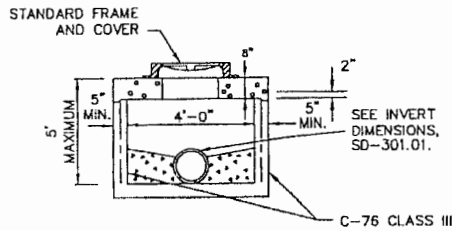
SD-300.01	Sanitary/Storm Manhole (Precast)
SD-301.01	Sanitary/Storm Manhole Details
SD-301.02	Sanitary/Storm Manhole Details
SD-301.03	Sanitary/Storm Manhole Details
SD-301.04	Sanitary/Storm Manhole Details
SD-302.01	Sanitary Manhole Drop Connection
SD-303.01	Sanitary Sewer Service Connection and Lateral
SD-304.01	Highway Crossing for Sanitary Sewers
SD-305.01	Creek and Ditch Crossings for Sanitary Sewers
SD-306.01	Trench Check Dam
SD-307.01	Trench Details/Bedding (Storm/Sanitary Sewers)
SD-308.01	Trench Details (Concrete Protection)
SD-308.02	Trench Details (Concrete Protection)
SD-309.01	Sewer Service Tap

NOTES

1. ALL MATERIALS, DESIGN, MANUFACTURE, PHYSICAL TEST REQUIREMENTS, FINISH, MARKING, INSPECTION, REJECTION, AND REPAIRS SHALL MEET A.S.T.M. C478 FOR PRECAST, REINFORCED CONCRETE MANHOLE RISERS AND TOPS EXCEPT AS MAY BE MODIFIED IN THESE SPECIFICATIONS.
2. SIZE AND LOCATE PIPE CUTOUTS AS REQUIRED.
3. MANHOLE STEPS - SEE MANHOLE STEPS DETAIL ON STANDARD NUMBER SD-301.04.
4. END-OF-LINE MANHOLES THAT HAVE FUTURE EXTENSIONS AND THAT ARE LOCATED IN PAVEMENT SHALL BE BACKFILLED WITH FLOWABLE FILL OR 33-P* STONE (PUG). THE BACKFILL SHALL BE COMPACTED TO 6-INCH LIFTS, AND SHALL EXTEND TEN (10') FEET FROM THE MANHOLE ALONG EACH TRENCH.
5. A MAXIMUM OF TWO CONCRETE RINGS MAY BE USED FOR ELEVATION ADJUSTMENT OF THE MANHOLE.
6. AN ECCENTRIC CONE MANHOLE SHALL NOT BE USED.



* "33-P (PUG)" - 303-01, TYPE A, GRADING D ("33-P"), TENNESSEE D.O.T. SPECIFICATIONS



PRECAST CONCRETE MANHOLES

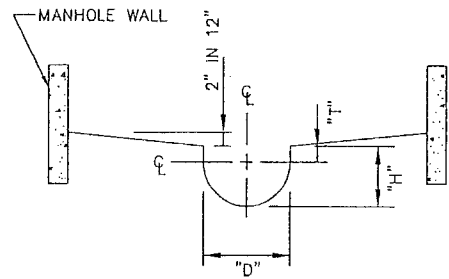


**CITY OF CHATTANOOGA AND HAMILTON COUNTY
SANITARY/STORM MANHOLE (PRECAST)**

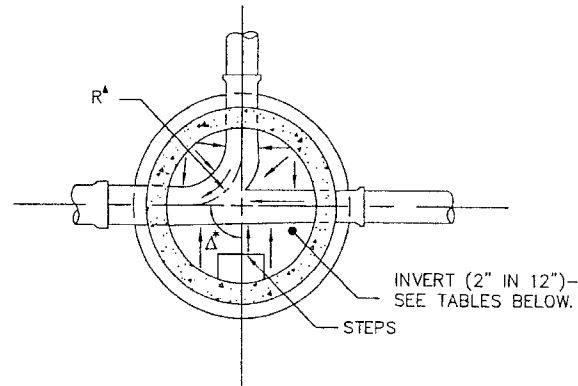
NO.	REVISION	DATE	DATE OF ORIGINAL ISSUE
1	REVISIONS AS MARKED OR CLOUDED	8/24/01	DECEMBER 10, 1999
0	INITIAL ISSUE	12/10/99	

STANDARD NUMBER : **SD-300.01**

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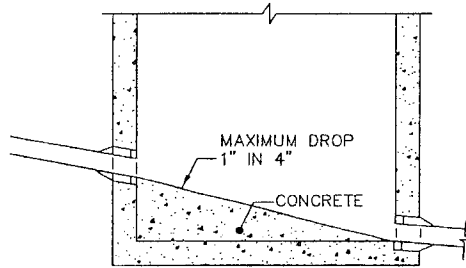


INVERT SECTION

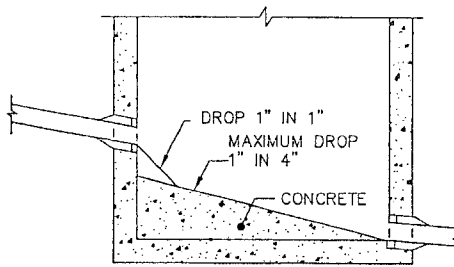


INVERT PLAN

NOTE
 "H" AND "T" DIMENSIONS APPLY AT BOTH THE UPSTREAM AND THE DOWNSTREAM EDGES OF MANHOLE. SEE TABLE 1.



INVERT DETAIL
 (WITH DROP LESS THAN 12")



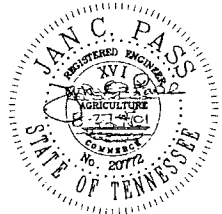
INVERT DETAIL
 (WITH DROP OF 12" TO LESS THAN 24")

TABLE I

"D" INSIDE DIAM. PIPE	"T" VERTICAL TANGENT	"H" HEIGHT OF INVERT
8"	2 1/2"	6 1/2"
10"	3"	8"
12"	3 1/2"	9 1/2"
15"	4 1/2"	12"
18"	5 1/2"	14 1/2"
21"	6 1/2"	17"
24"	7 1/2"	19 1/2"
30"	9"	24"
36"	11"	29"

TABLE II
 GOVERNING DIMENSIONS FOR MANHOLE INVERTS

PIPE SIZE	Δ ^A ANGLE	BASE DIAM.	R ^A
8" THRU 12"	0° TO 90°	4'	1'-6"
15"	0° TO 60°	4'	1'-10"
15"	60+ TO 90°	4'	1'-10"
18"	0° TO 60°	4'	2'-3"
18"	60+ TO 90°	4'	1'-10"
21"	0° TO 60°	4'	2'-7"
21"	60+ TO 90°	5'	2'-4"
24"	0° TO 45°	4'	3'-0"
24"	45+ TO 90°	5'	2'-3"
30"	0° TO 60°	5'	3'-9"
30"	60+ TO 90°	6'	2'-8"
36"	0° TO 30°	6'	4'-6"
LARGER THAN 36"	0° TO 90°	SEE PLANS	



NO.	REVISION	DATE
1	REVISIONS AS MARKED OR CLOUDED	8/24/01
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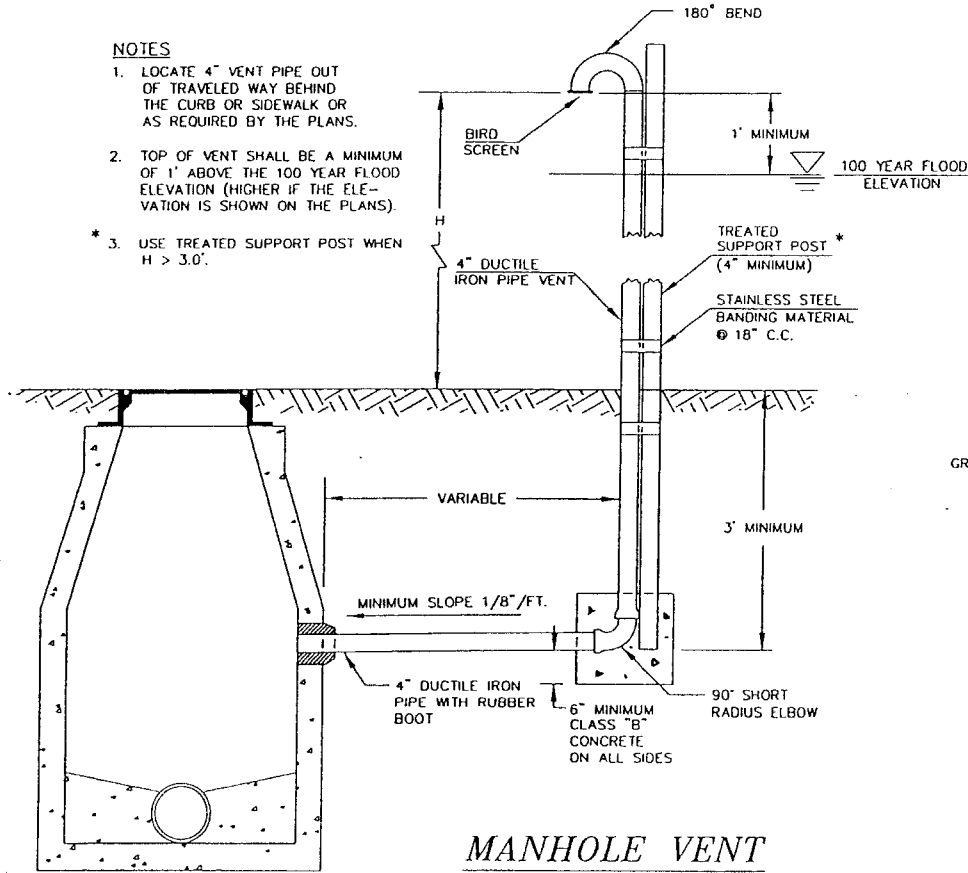
CITY OF CHATTANOOGA AND HAMILTON COUNTY
SANITARY/STORM MANHOLE DETAILS

DATE OF ORIGINAL ISSUE
DECEMBER 10, 1999

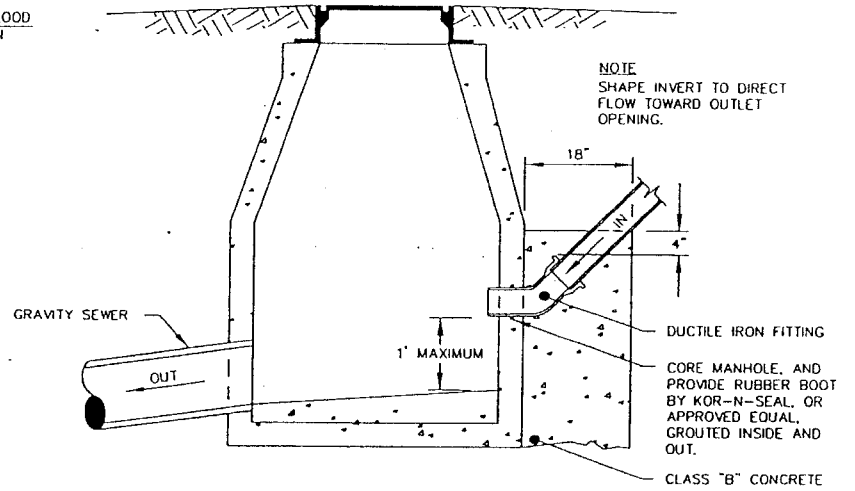
STANDARD NUMBER: **SD-301.01**

NOTES

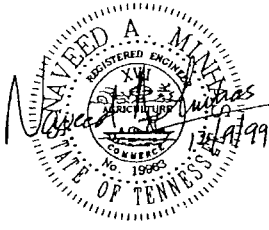
1. LOCATE 4" VENT PIPE OUT OF TRAVELED WAY BEHIND THE CURB OR SIDEWALK OR AS REQUIRED BY THE PLANS.
2. TOP OF VENT SHALL BE A MINIMUM OF 1' ABOVE THE 100 YEAR FLOOD ELEVATION (HIGHER IF THE ELEVATION IS SHOWN ON THE PLANS).
- * 3. USE TREATED SUPPORT POST WHEN $H > 3.0'$.



MANHOLE VENT



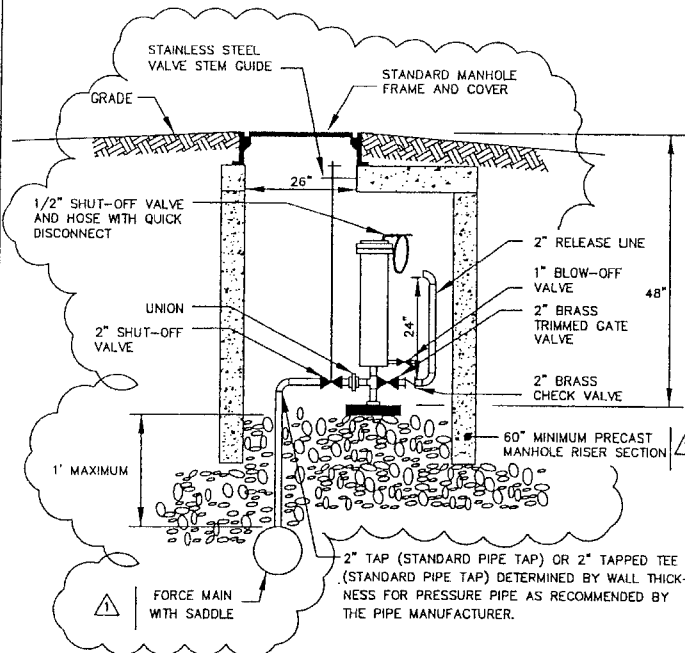
CONNECTION OF FORCE MAIN TO MANHOLE



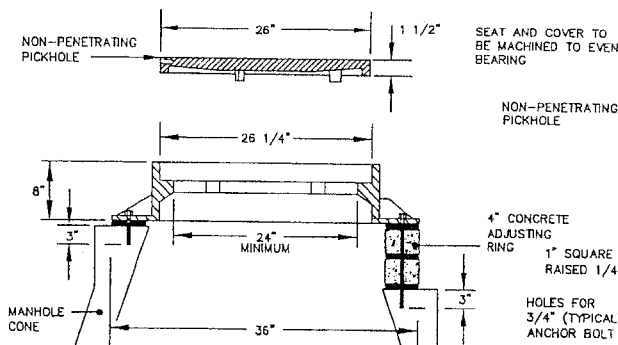
CITY OF CHATTANOOGA AND HAMILTON COUNTY			
<i>SANITARY/STORM MANHOLE DETAILS</i>			
0	INITIAL ISSUE	12/10/99	DATE OF ORIGINAL ISSUE
NO.	REVISION	DATE	DECEMBER 10, 1999
			STANDARD NUMBER: SD-301.02

NOTES

1. AIR RELEASE VALVE IS TO BE "CRISPIN SEWER VALVE", APCO 400 SEWAGE VALVE, OR EQUAL.
2. AIR-VACUUM VALVE INSTALLATION IS TO BE SIMILAR EXCEPT THAT THE VALVE IS TO BE APCO 402 SEWAGE VALVE, OR EQUAL.
3. 2" RELEASE LINE, GATE VALVE, AND CHECK VALVE ON AIR-VACUUM VALVE ONLY.

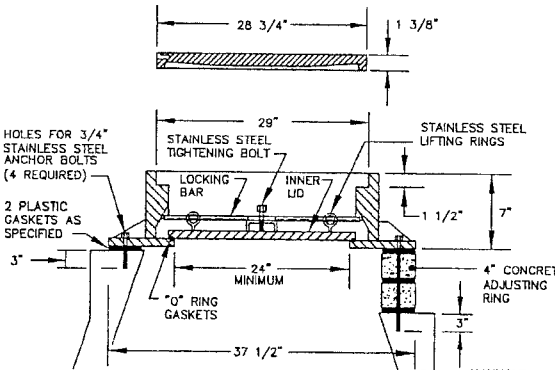


**AIR RELEASE VALVE
(SANITARY FORCE MAIN)**



**SECTION
STANDARD FRAME AND COVER**

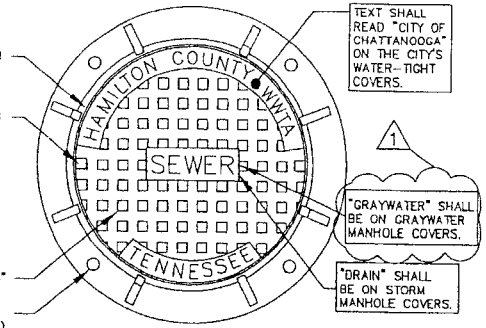
ACHESON FOUNDRY A-2024-B1C (CITY),
A-2024-B1D (CITY-"DRAIN"),
A-2024-B1H (COUNTY),
OR APPROVED EQUAL



**SECTION
WATER-TIGHT FRAME
AND COVER**

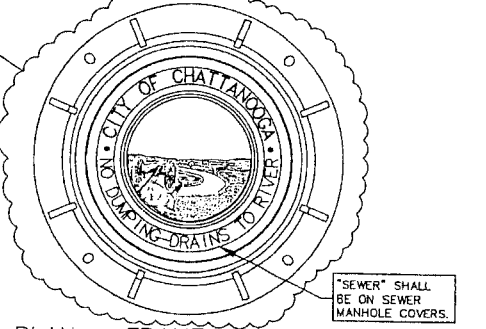
ACHESON FOUNDRY A-2624-71C (CITY),
A-2624-71H (COUNTY),
OR APPROVED EQUAL

MANHOLE FRAME AND COVER



PLAN - FRAME AND COVER

ACHESON FOUNDRY (STANDARD) A-2024-B1H (COUNTY),
(WATER-TIGHT) A-2624-71H (COUNTY),
(WATER-TIGHT) A-2624-71C (CITY),
OR APPROVED EQUAL



PLAN - FRAME AND COVER

ACHESON FOUNDRY (STANDARD) A-2024-B1D (CITY),
(STANDARD) A-2024-B1C (CITY-"SEWER"),
OR APPROVED EQUAL

	SPECIFIED MINIMUM WEIGHTS	
	STANDARD	WATERTIGHT
COVER	165 LBS.	190 LBS.
FRAME	185 LBS.	400 LBS.
TOTAL	350 LBS.	590 LBS.

NOTES

1. THE MANUFACTURER SHALL CERTIFY THE TRAFFIC BEARING CAPACITY OF FRAMES AND COVERS.
2. MANHOLES IN PAVED AREAS MAY NOT REQUIRE ANCHOR BOLTS.
3. BEARING SURFACES BETWEEN COVER AND FRAME SHALL BE MACHINED TO PREVENT ROCKING.

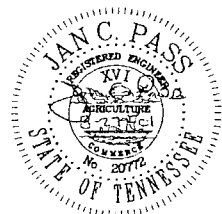
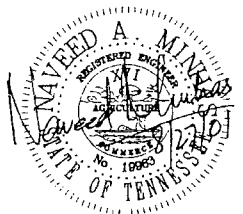
**CITY OF CHATTANOOGA AND HAMILTON COUNTY
SANITARY/STORM MANHOLE DETAILS**

NO.	REVISIONS AS MARKED OR CLOUDED	DATE
1	REVISIONS AS MARKED OR CLOUDED	8/24/01
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	REVISION	DATE

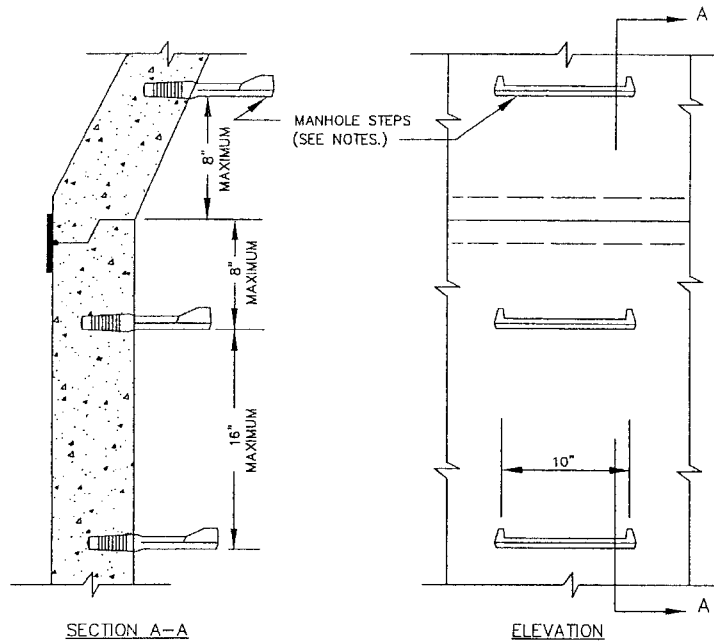
DATE OF ORIGINAL ISSUE
DECEMBER 10, 1999

STANDARD NUMBER : **SD-301.03**

FASTDDWGSManhole-ForceMain-CountyManholewithForceMain_3PRINTABLEGREY.dwg



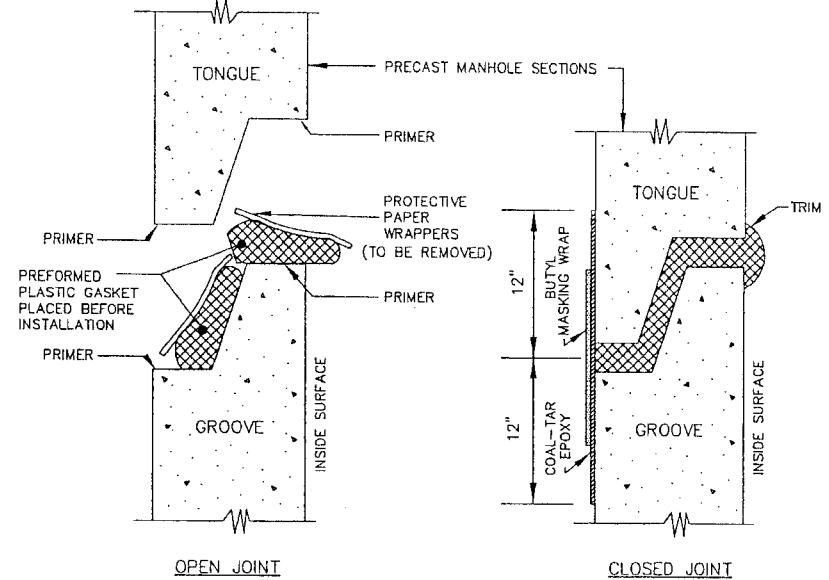
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NOTES

1. STEPS SHALL BE 3/8" STEEL REINFORCED ROD ENCAPSULATED IN POLYPROPYLENE PLASTIC.
2. RISER SECTIONS SHALL BE SET SO THAT STEPS ALIGN VERTICALLY.
3. THE FIRST STEP SHALL BE NO MORE THAN 16" BELOW THE TOP OF THE MANHOLE CONE.

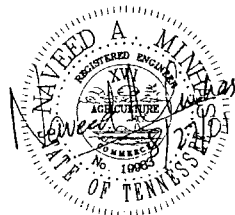
MANHOLE STEPS



NOTES

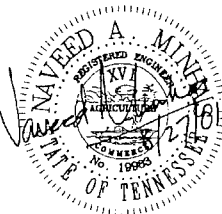
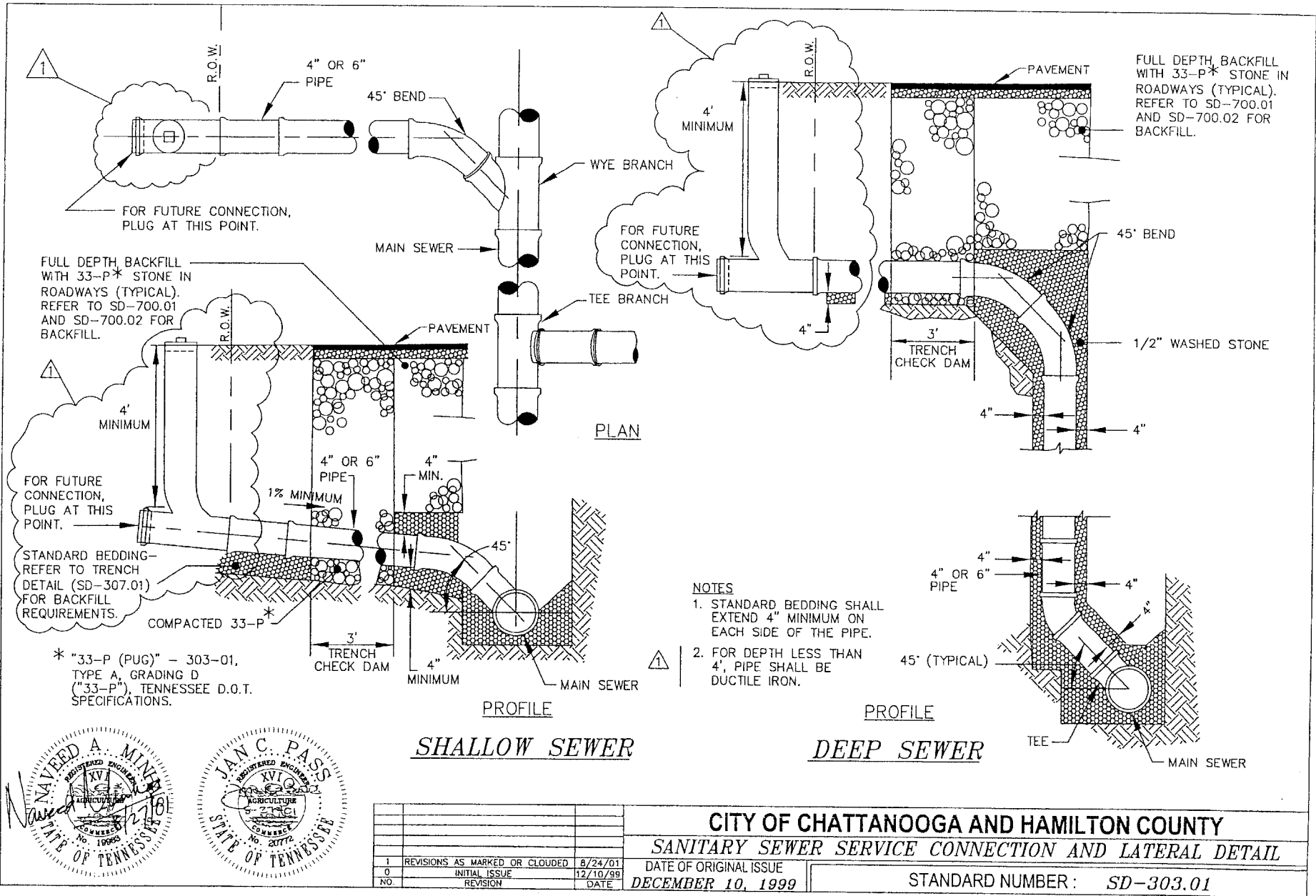
1. CLEAN ALL DEBRIS FROM JOINTS PRIOR TO GASKET APPLICATION.
2. TRIM PROTRUDING GASKET INSIDE AND OUTSIDE.

**JOINT AND GASKET FOR
PRECAST MANHOLE SECTIONS**



		CITY OF CHATTANOOGA AND HAMILTON COUNTY	
		<i>SANITARY/STORM MANHOLE DETAILS</i>	
1	REVISIONS AS MARKED OR CLOUDED	8/24/01	DATE OF ORIGINAL ISSUE
0	INITIAL ISSUE	12/10/99	DECEMBER 10, 1999
NO.	REVISION	DATE	STANDARD NUMBER: SD-301.04

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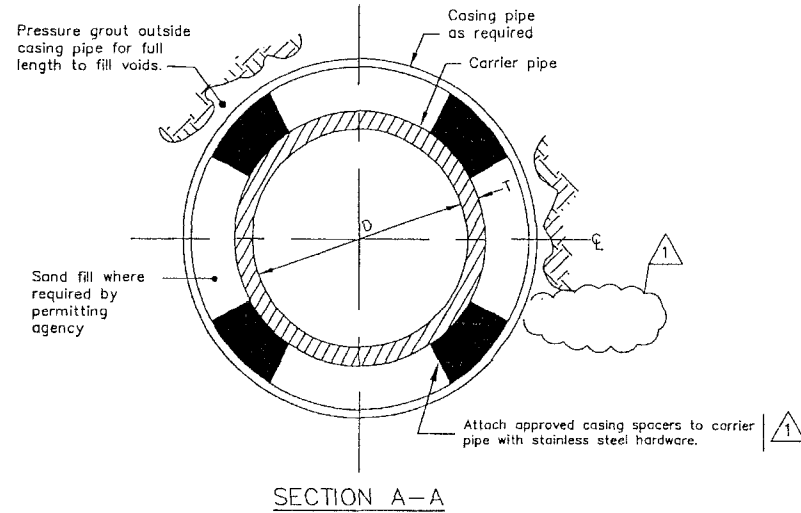
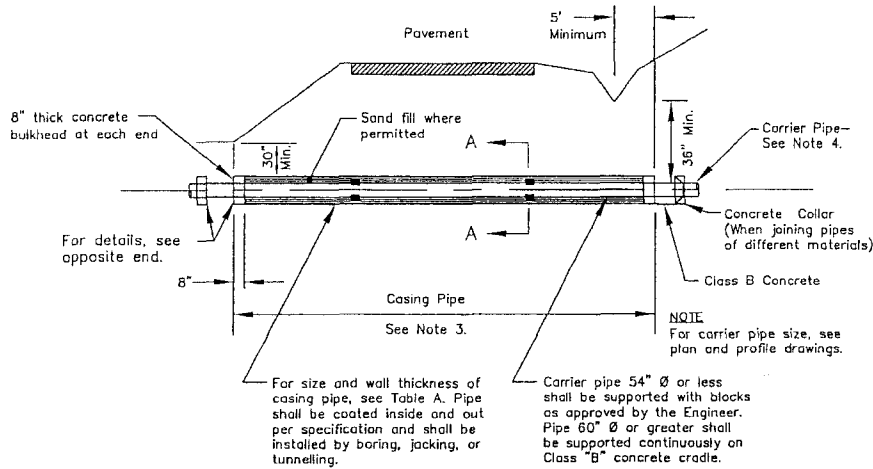


TABLE "A"		
PIPE SIZE		
Carrier Pipe (Inches)	Casing Pipe	
	Diameter (Inches)	Steel Pipe Wall Thick
8	18	1/4"
10	20	5/16"
12	24	3/8"
14	30	1/2"
18	36	1/2"
24	36	1/2"
30	54	SEE TABLE "B"
36	54	...
42	86	...
48	72	...
54	78	...
60	84	...
66	96	...
72	108	...
84	120	...
96	144	...

TABLE "B"	
Gauges of Liner Plate For Continuous Load-Carrying Structures	
Nominal Diameter (Inches)	Height of Cover (Feet)
	2-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45
48	12 12 12 12 12 12 12 12 10
54	12 12 12 12 12 12 12 12 10 8
60	12 12 12 12 12 12 10 8 7
66	12 12 12 12 12 10 8 8 5
72	12 12 12 12 12 10 8 7 5
78	12 12 12 12 10 8 7 5 5
84	12 12 12 10 10 8 5 5 5
96	12 10 10 10 10 8 5 5 5
108	10 10 10 10 8 7 5 5 5
120	10 10 10 8 8 7 5 5 3
144	8 8 8 8 5 5 3 1 1

* Ductile Iron Or Cast Iron
R.C.P.

△ * HAMILTON COUNTY WMTA ALLOWS PVC PIPE.

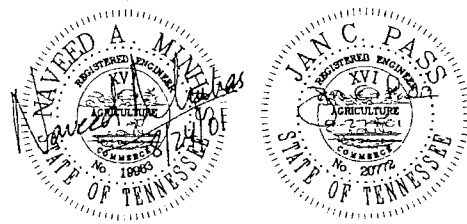
HIGHWAY CROSSING NOTES FOR PLACING SEWER LINES WITHIN THE RIGHT-OF-WAY OR CROSSING STATE AND U.S. HIGHWAYS AND DESIGNATED CITY STREETS

1. LINES CROSSING UNDER PAVED ROADS AND PAVED CROSSROADS WITHIN DESIGNATED CITY STREETS, AND STATE AND U.S. HIGHWAY RIGHTS-OF-WAY SHALL BE ENCASED AND INSTALLED BY BORING, JACKING, OR TUNNELLING. CASING PIPE SHALL EXTEND FROM TOE OF SHOULDER SLOPE TO TOE OF SHOULDER SLOPE. ALL WORK SHALL BE DONE AS SHOWN ON THIS DRAWING.
2. ALL LINES SHALL HAVE A MINIMUM COVER OF 30" EXCEPT WHERE DEEPER COVER IS INDICATED ON THE DRAWINGS. ALL TRENCH EXCAVATION WITHIN THE RIGHT-OF-WAY AND NOT UNDER PAVING SHALL BE BACKFILLED BY TAMPING IN 6" LAYERS. ALL SURPLUS MATERIAL SHALL BE REMOVED FROM THE RIGHT-OF-WAY, AND THE EXCAVATION SHALL THEN BE FINISHED FLUSH WITH THE SURROUNDING GROUND.
3. CASING PIPE SHALL BE EITHER SPIRAL WELDED STEEL PIPE OR STEEL LINER PLATE, APPLICABLE AND SUITABLE TO THE METHOD OF INSTALLATION EMPLOYED (SEE TABLE "A"). ALL CASING PIPE SHALL BE COATED INSIDE AND OUT PER SPECIFICATIONS.
4. CARRIER PIPE FOR ALL LINES 6" TO 54" IN DIAMETER SHALL BE CAST OR DUCTILE IRON PIPE * WITH "PUSH-ON" TYPE JOINTS. CARRIER PIPE 60" IN DIAMETER AND LARGER SHALL BE REINFORCED CONCRETE WITH "BELL AND SPIGOT" JOINTS. FOR SIZE, SEE PLAN AND PROFILE DRAWINGS.
5. ALL INSTALLATIONS SHALL BE DONE TO LEAVE FREE FLOWS IN DRAINAGE DITCHES, PIPES, CULVERTS, OR OTHER SURFACE WATER DRAINAGE FACILITIES OF THE HIGHWAY OR STREET OR ITS CONNECTIONS.
6. THE CONTRACTOR SHALL MAKE NECESSARY ARRANGEMENTS FOR HIGHWAY TRAFFIC OVER THE CONSTRUCTION AREA DURING SUCH WORK AND SHALL PLACE NECESSARY BARRICADES, WARNING SIGNS, SIGNALS, LIGHTS, AND, IF NECESSARY, WATCHMEN FOR THE TRAVELING PUBLIC.

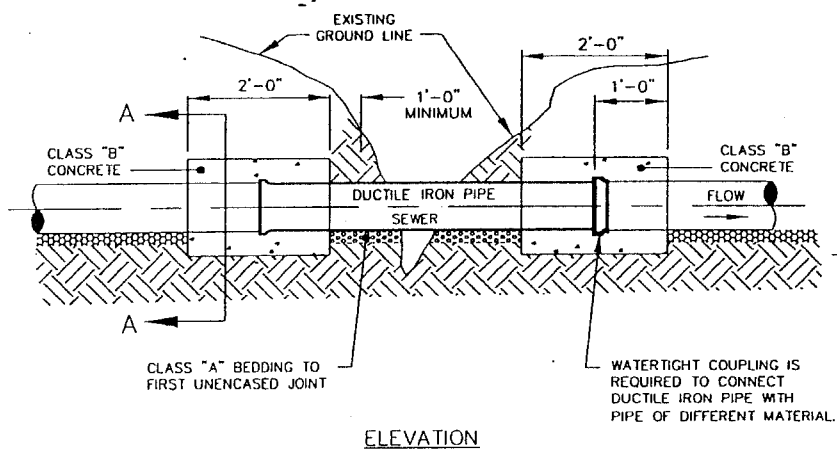
CASING PIPE

SIZE AND THICKNESS OF PIPE FOR HIGHWAY CROSSING

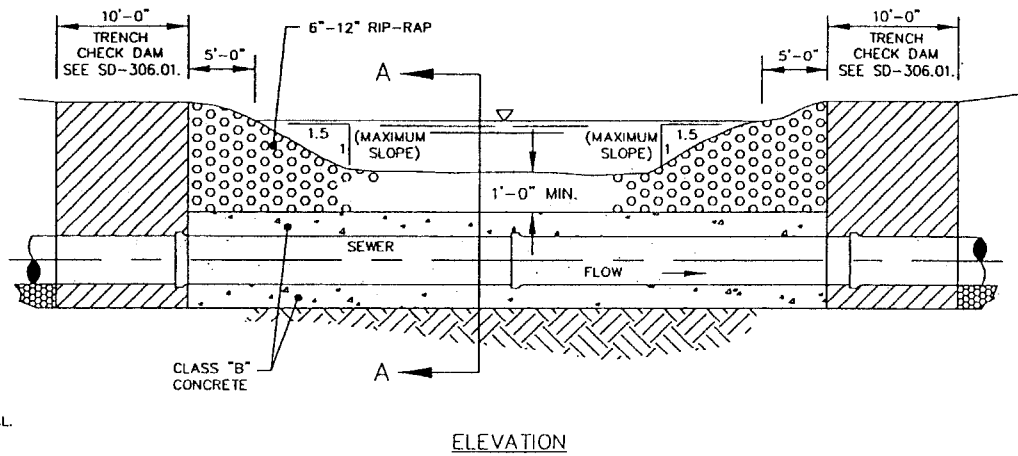
HIGHWAY CROSSING DETAILS



CITY OF CHATTANOOGA AND HAMILTON COUNTY			
HIGHWAY CROSSING FOR SANITARY SEWERS			
1	REVISIONS AS MARKED OR CLOUDED	8/24/01	DATE OF ORIGINAL ISSUE DECEMBER 10, 1999
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NO.	REVISION	DATE	STANDARD NUMBER: SD-304.01

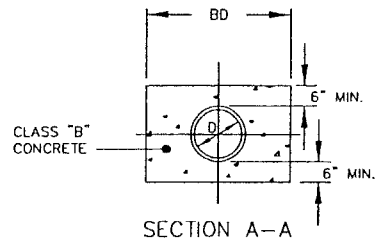


DITCH CROSSING DETAIL



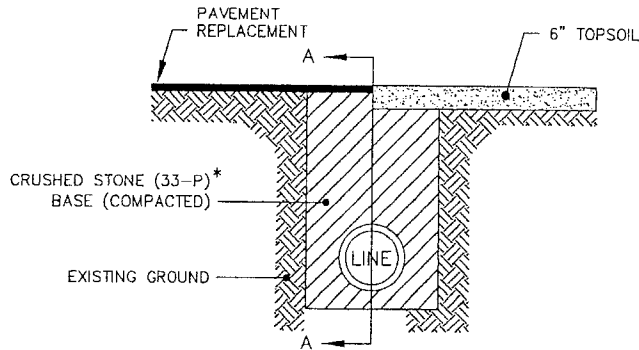
CREEK CROSSING DETAIL

PIPE SIZE "D" (IN)	TRENCH WIDTH "BD" (FT)
6	2.00
8	2.33
10	2.50
12	2.67
15	3.00
18	3.25
24	3.83
30	4.42
36	5.67
42	6.25
48	6.83

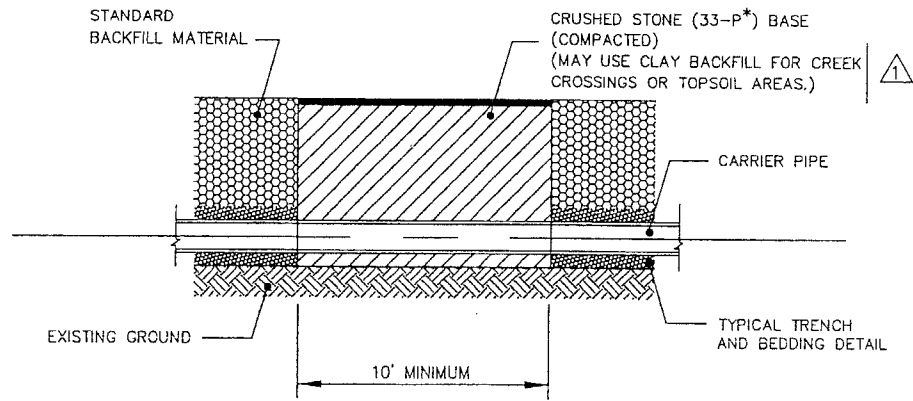


CITY OF CHATTANOOGA AND HAMILTON COUNTY		
<i>CREEK AND DITCH CROSSINGS FOR SANITARY SEWERS</i>		
0	INITIAL ISSUE	DATE OF ORIGINAL ISSUE
NO.	REVISION	DATE
		DECEMBER 10, 1999
		STANDARD NUMBER: <i>SD-305.01</i>

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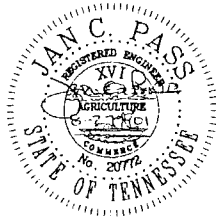
END VIEW
(SPLIT SECTION)



SECTION A-A

* "33-P (PUG)" - 303-01, TYPE A, GRADING D ("33-P"), TENNESSEE D.O.T. SPECIFICATIONS.

NOTE
A CHECK DAM SHALL BE LOCATED EVERY 500'
ALONG THE TRENCH UNLESS SHOWN OTHERWISE
ON THE PLANS.



CITY OF CHATTANOOGA AND HAMILTON COUNTY
TRENCH CHECK DAM

1	REVISIONS AS MARKED OR CLOUDED	8/24/01	DATE OF ORIGINAL ISSUE	
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NO.	REVISION	DATE		STANDARD NUMBER: SD-306.01

PIPE DIAMETER "D" (INCHES)	TRENCH WIDTH "BD" (FEET)	TRENCH* VOLUME PER FOOT OF DEPTH	CLASS "C" BEDDING FOR CONCRETE AND DUCTILE IRON		ROCK TRENCH BEDDING	
			QTY. (C.Y.)	"S" IN (IN.)	CONC. & D.I.	PVC, ETC.
6	2.00	0.074	0.025	4-1/4	0.025	0.037
8	2.33	0.086	0.030	4-1/2	0.030	0.043
10	2.50	0.093	0.036	5-0	0.049	0.062
12	2.67	0.099	0.039	5-1/4	0.054	0.066
15	3.00	0.111	0.046	5-3/4	0.063	0.074
18	3.25	0.120	0.053	6-1/4	0.069	0.080
24	3.83	0.142	0.072	7-1/2	0.108	0.118
30	4.42	0.164	0.098	9-0	0.121	0.137
36	5.67	0.210	0.148	10-1/2	0.194	-----
42	6.25	0.231	0.184	12-0	0.209	-----
48	6.83	0.253	0.223	13-1/2	0.223	-----
54	7.42	0.275	0.226	15-0	0.236	-----
60	8.00	0.296	0.312	16-1/2	0.247	-----
66	8.58	0.318	0.362	18-0	0.258	-----
72	9.17	0.340	0.416	19-1/2	0.268	-----
78	9.75	0.361	0.458	20-1/2	0.291	-----
84	10.33	0.383	0.510	21-3/4	0.315	-----
96	11.50	0.426	0.604	23-3/4	0.365	-----

* ALL VOLUMES IN CUBIC YARDS/LINEAR FOOT.

** QUANTITIES AND DIMENSIONS FOR 6" SERVICE LINE SHALL APPLY TO 4" SERVICE LINE ALSO.
 QUANTITIES FOR CLASS "B" AND ROCK TRENCH BEDDING ARE THE QUANTITIES IN EXCESS OF THOSE REQUIRED FOR CLASS "C" BEDDING.

SCHEDULE OF BEDDING

PIPE DIAMETER "D" (INCHES)	TRENCH WIDTH TOP OF PIPE "BD" (FT.)	CONCRETE PIPE C-76 CLASS III	CONCRETE PIPE C-76 ALWA C-301 D.I.P.	PVC D-3034 AND ASTM F679
CLASS "C" BEDDING (STANDARD BEDDING)				
4"	2.00	---	---	NL
6"	2.00	---	---	NL
8"	2.33	---	---	NL
10"	2.50	---	---	NL
12"	2.67	---	13	NL
15"	3.00	---	12	NL
18"	3.25	---	13	NL
21"	3.54	---	14	NL
24"	3.83	---	15	---
27"	4.08	11	15	---
30"	4.42	11	16	---
33"	4.75	11	16	---
36"	5.67	10	14	---
42"	6.25	11	16	---
48"	6.83	12	17	---
54"	7.42	13	18	---
60"	8.00	13	18	---
66"	8.58	14	19	---
72"	9.17	15	20	---
78"	9.75	16	21	---
84"	10.33	16	21	---
90"				

NL=NO LIMIT TO BOTTOM OF PIPE

BD=MAXIMUM TRENCH WIDTH AT 12" ABOVE TOP OF PIPE. IF DITCH IS CUT WIDER THAN BD SHOWN, THE CONTRACTOR, AT HIS OWN EXPENSE, WILL BE REQUIRED TO INCREASE BEDDING TO COMPENSATE FOR ADDITIONAL LOAD ON THE PIPE.

(PERMISSIBLE DEPTH (IN FEET) TO BOTTOM OF PIPE FOR SATURATED CLAY EARTH LOAD, 130 LBS./CU. FT. (SATURATED CLAY).)

NOTES

STANDARD BEDDING

MATERIAL SHALL BE PLACED AS SHOWN BY THE STANDARD DETAILS FOR THE TYPE OF PIPE USED. THE BEDDING SHALL BE INCLUDED FOR PAYMENT IN THE UNIT PRICE BID PER LINEAR FOOT OF PIPE FOR VARIOUS TYPES, SIZES, AND DEPTHS LISTED IN THE BID SCHEDULE.

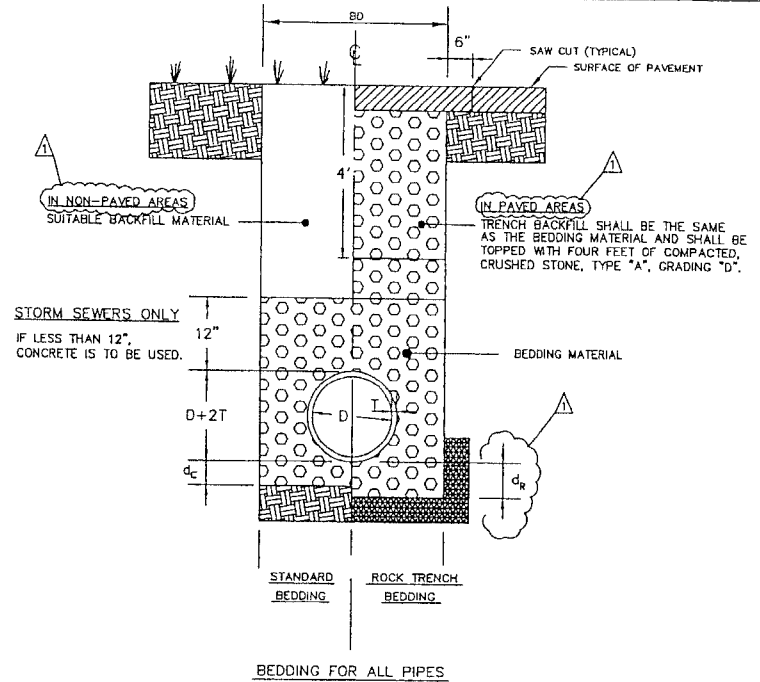
CLASS "B" BEDDING MATERIAL (SECTION 204.04, TENNESSEE D.O.T. SPECIFICATIONS)- MATERIAL FOR CLASS "B" BEDDING FOR PIPE CULVERTS SHALL CONSIST OF SAND OR A NATURAL SANDY SOIL, ALL OF WHICH PASSES A 3/8-INCH SIEVE AND NOT MORE THAN TEN PERCENT PASSES A NO. 200 SIEVE; OR STONE, GRAVEL, CHERT, OR SLAG MEETING THE GRADING REQUIREMENTS FOR EITHER GRADING C, D, OR E OF SUBSECTION 903.05.

IN ROCK CUTS OR OTHER AREAS DESIGNATED BY THE ENGINEER WHERE A FREE DRAINAGE BEDDING OR BACKFILL MATERIAL IS REQUIRED, THE MATERIAL SHALL BE CRUSHED STONE, CRUSHED SLAG, OR WASHED GRAVEL MEETING THE REQUIREMENTS OF SUBSECTION 903.17.

PVC PIPE BEDDING MATERIAL-NO. 7 WASHED STONE (SECTION 903.22, TENNESSEE D.O.T. SPECIFICATIONS).

ROCK TRENCH BEDDING

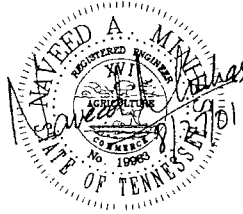
MATERIAL SHALL BE SAME AS FOR CLASS "B" BEDDING AND SHALL BE PLACED AS SHOWN BY THE STANDARD DETAILS FOR THE TYPE OF PIPE USED. QUANTITIES FOR THE ROCK TRENCH BEDDING ARE THE AMOUNTS IN EXCESS OF THOSE REQUIRED FOR CLASS "C" BEDDING.



TRENCH DETAILS

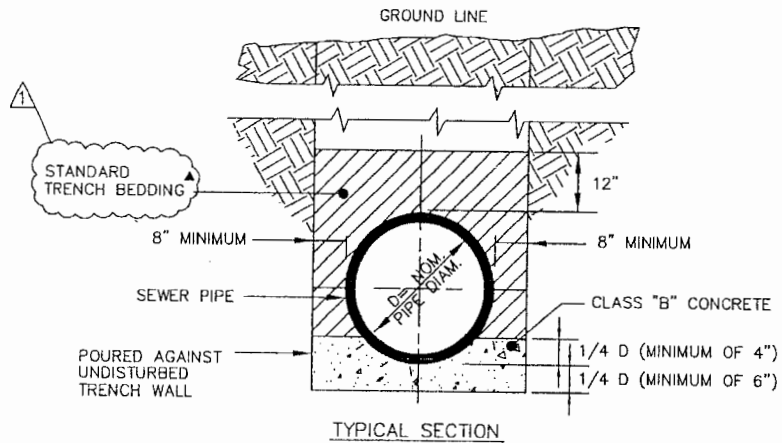
D	d _c	d _r
8" AND LESS	6"	10"
10" TO 18"	8"	12"
20" TO 30"	10"	14"
32" AND LARGER	12"	16"

F:\STDD\WGSI\TrenchDetails\STDTRNCH.dwg



CITY OF CHATTANOOGA AND HAMILTON COUNTY			
TRENCH DETAILS AND BEDDING (STORM/SANITARY SEWERS)			
1	REVISIONS AS MARKED OR CLOUDED	8/24/01	DATE OF ORIGINAL ISSUE
0	INITIAL ISSUE	12/10/99	DECEMBER 10, 1999
NO.	REVISION	DATE	STANDARD NUMBER: SD-307.01

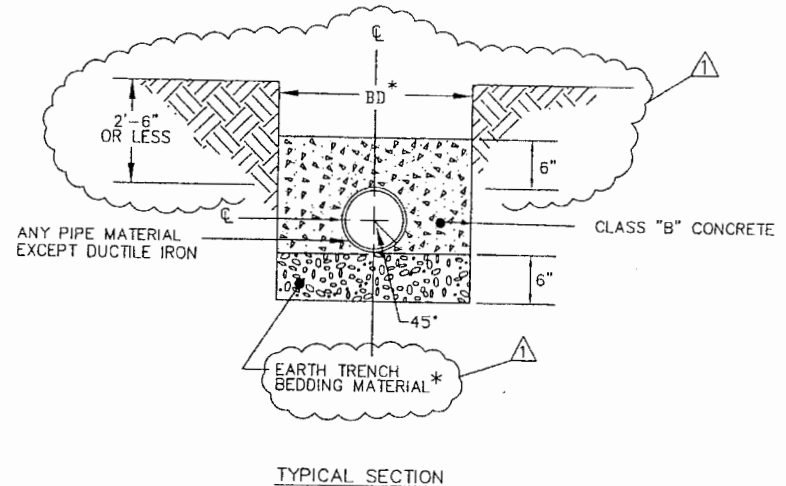
F:\STDD\WGSI\TrenchDetails-County-Combined(concrete)_1.dwg



CONCRETE CRADLE

NOTES

1. CLASS "B" CONCRETE IS TO BE POURED 16 HOURS BEFORE PLACING BACKFILL, AND IN A MANNER THAT PREVENTS THE FLOATING OF PIPES.
2. PIPES ARE TO BE LAID BEFORE THE CONCRETE HARDENS.
- ▲ 3. SEE STANDARD DRAWING SD-307.01.



CONCRETE CAP FOR SHALLOW PIPE

NOTES

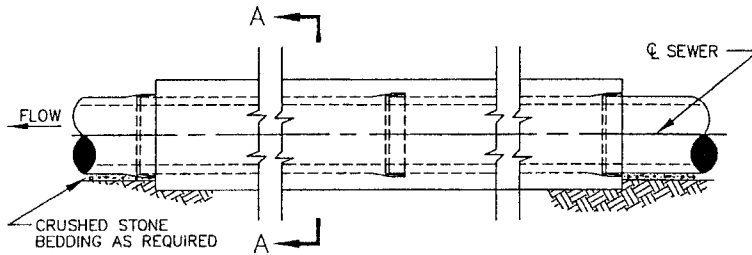
1. CLASS "B" CONCRETE IS TO BE POURED 36 HOURS BEFORE PLACING BACKFILL, AND IN A MANNER THAT PREVENTS THE FLOATING OF PIPES.
2. CONCRETE ENCASEMENT IS REQUIRED FOR DITCHES AND CREEKS WHERE THE COVER IS 2'-6" OR LESS.
- ▲ * 3. SEE STANDARD DRAWING SD-307.01.



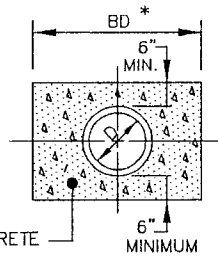
NO.	REVISION	DATE
1	REVISIONS AS MARKED OR CLOUDED	8/24/01
0	INITIAL ISSUE	12/10/99

CITY OF CHATTANOOGA AND HAMILTON COUNTY	
<i>TRENCH DETAILS (CONCRETE PROTECTION)</i>	
DATE OF ORIGINAL ISSUE DECEMBER 10, 1999	STANDARD NUMBER : SD-308.01

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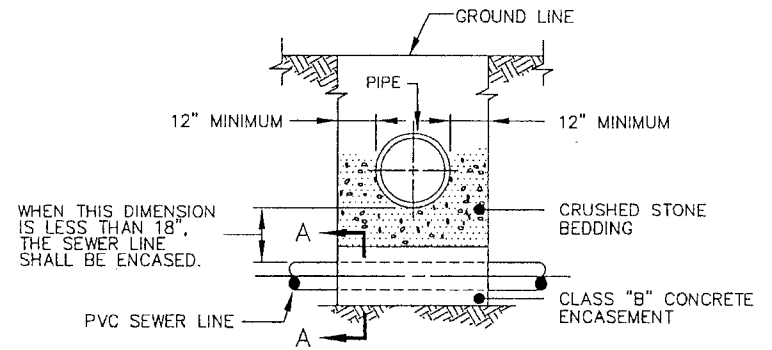
ELEVATION



CLASS "B" CONCRETE
ENCASEMENT

SECTION A-A

BD* - SEE STANDARD
SD-307.01.



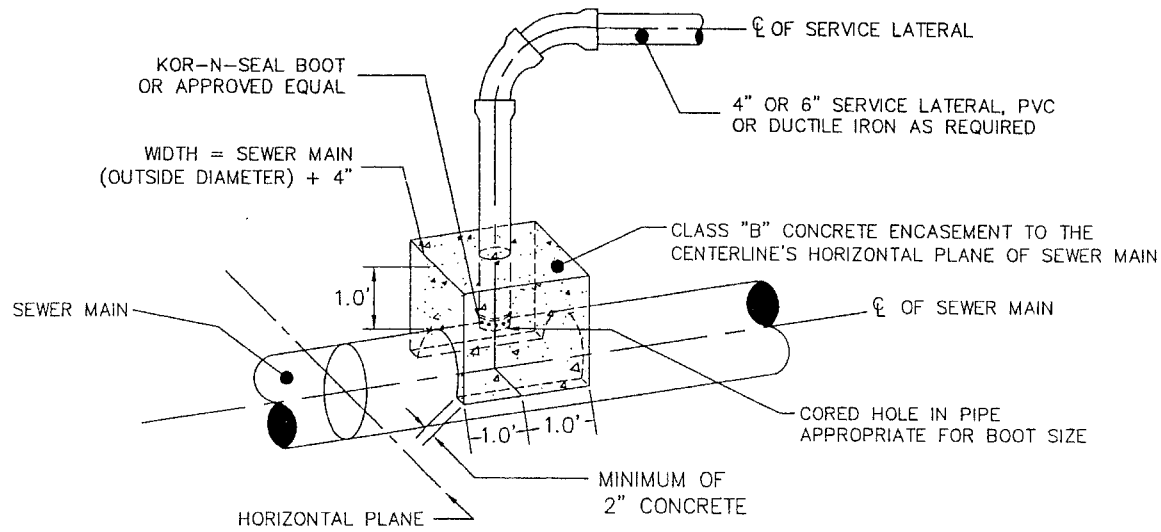
WHEN THIS DIMENSION
IS LESS THAN 18",
THE SEWER LINE
SHALL BE ENCASED.

CONCRETE ENCASEMENT



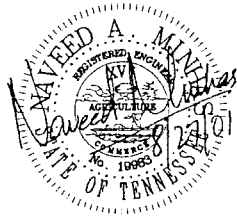
CITY OF CHATTANOOGA AND HAMILTON COUNTY			
<i>TRENCH DETAILS (CONCRETE PROTECTION)</i>			
1	DELETED TABLE	8/24/01	DATE OF ORIGINAL ISSUE
0	INITIAL ISSUE	12/10/99	STANDARD NUMBER : SD-308.02
NO.	REVISION	DATE	

F:\STDD\WGS\Sewer Service Tap\Service Taps (1.5 inch).dwg



NOTE

ALL SUCH CONNECTIONS TO PIPES 15" OR LARGER MUST HAVE PRIOR APPROVAL BY CITY.



0	INITIAL ISSUE	8/24/01
NO.	REVISION	DATE

CITY OF CHATTANOOGA AND HAMILTON COUNTY	
SEWER SERVICE TAP (15" OR LARGER SEWER MAIN)	
DATE OF ORIGINAL ISSUE	STANDARD NUMBER: SD-309.01
AUGUST 24, 2001	

APPENDIX D
RESUMES OF KEY CITY ENGINEERS

Alice L. Cannella, P.E.

PROFESSIONAL EXPERIENCE

2002 to present	Plant Superintendent	City of Chattanooga, Tennessee Interceptor Sewer System
1991 to 2002	System Engineer	City of Chattanooga, Tennessee Interceptor Sewer System
1990 to 1991	Professional Engineer	Fyie Engineering
1984 to 1990	Director Engineering Developm	Hamilton County Government
1981 to 1984	Project Engineer	Hamilton County Government
1979 to 1981	Research Analyst	Tennessee Valley Authority
1978 to 1979	Environmental Engineer	Tennessee Valley Authority

EDUCATION

B.S. Civil Engineering, Tennessee Technological University, 1978

PROFESSIONAL REGISTRATIONS

Professional Engineer – Tennessee, Number 15868
Certified Grade II Collection System Operator – Tennessee
Certified Grade IV Wastewater Plant Operator – Tennessee

PROFESSIONAL ASSOCIATIONS

Water Environment Federation
Society of Women Engineers
Board of Engineering Advisors – Tennessee Technological University
Engineering Development Foundation – Tennessee Technological University

Naveed A. Minhas P.E.

PROFESSIONAL EXPERIENCE

2004- Present	City Engineer	City of Chattanooga TN
1996 - 2003	Engineering Manager	City of Chattanooga, TN
1992 - 1994	Project Manager	Stone & Webster Engineering, MA
1973 - 1992	Supervising Engineer	United Engineers, Philadelphia, PA
1970 - 1973	Bridge Engineer	Urban Engineers, Philadelphia, PA
1968 - 1970	Assistant Director	Capital Development Authority, Islamabad, Pakistan

EXPERIENCE HIGHLIGHTS

Project Management- Design through construction. The types of Projects include multi-story buildings, bridges, Nuclear Power Plants, highways, Waste Resources Projects, streetscapes and other related Civil Projects.

EDUCATION

Masters of Business Administration (MBA); Nova University, FL., 1985
M.S. Civil Engineering Courses, University of Pennsylvania, 1975
B.S. Civil Engineering, University of Pakistan, 1968

SPECIALITY COURSES/TRAINING

Fall out Shelter Analysis Certification
American Welding Society Certification
Total Quality Management Training

PROFESSIONAL REGISTRATIONS

Registered Professional Engineer- Tennessee, Pennsylvania and Washington

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers
American Society of Mechanical Engineers
American Public Works Association
Engineers Club-Chattanooga, TN
Affiliate Broker, Chattanooga, TN

Engineering Experience of Michael C. Patrick

Education: Bachelor of Science in Engineering, Mechanical
University of TN at Chattanooga, 1992

Employment Experience:

Landfill Technician – 11/28/92 to 12/22/95 (City of Chattanooga)

Responsible for maintenance and operation of the City of Chattanooga's landfill gas recovery system.

Responsible for development and implementation of hazardous waste detection and disposal procedures for incoming waste loads at landfill.

Performed land surveys and project layouts using field surveying equipment.

Developed topographic maps and performed landfill volume usage calculations.

Prepared site plans, specifications and permit documents for Composting operation at the City of Chattanooga Wood Recycling Center.

Prepared site plans and permit documents for Tire Storage facility at landfill.

Landfill Engineering Technician – 12/23/95 to 11/19/98 (City of Chattanooga)

Responsible for Landfill Technician duties described above.

Prepared drawings and specifications for landfill leachate collection system.

Designed and prepared specifications for landfill gas well de-watering system.

Performed gas system performance studies and developed plans and specifications for gas system improvements.

Monitored construction of Subtitle D landfill liner, leachate pumping stations and various gas system improvement projects.

Responsible for design and layout of waste cells to correspond to permit requirements.

Responsible for layout and construction of landfill slopes and terraces to meet construction plan requirements.

Performed plan reviews for landfill construction and permitting.

Performed waste compaction studies.

Responsible for development and implementation of stormwater pollution prevention plan. Designed and constructed temporary erosion control measures as necessary.

Landfill Supervisor – 11/20/98 to 8/22/03 (City of Chattanooga)

Responsible for daily operation of landfill, budgeting and long term planning.

Responsible for compliance of landfill with all applicable federal, state and local rules and regulations. Initiated any actions necessary to correct deviations or violations.

Responsible for new landfill facility layout.

Provided engineer of record with recommendations for modifications to the landfill design to increase serviceability of various structures and equipment.

Designed and supervised construction of numerous roadways and drainage structures to facilitate vehicular access and minimize stormwater contamination.

Responsible for development and implementation of Title V, NSPS and local air pollution prevention and control plans at operating and closed landfills.

Responsible for oversight of gas flare emissions testing.

Responsible for NPDES permit implementation at operating and closed landfills.

Responsible for design and construction of modifications to leachate collection, landfill gas and truck washing systems.

Responsible for operation, maintenance, and modification to numerous leachate pumping stations with capacities ranging from 10 to 700 gpm.

Designed and supervised construction of a 100 gpm, dual-contained, leachate pumping station and force main to convey leachate from one area of landfill to another.

Prepared initial design for 1000 cfm landfill gas flare with horizontal collection system to facilitate the removal of gas during landfilling operations.

Evaluated landfill gas system data, made recommendations, and assisted consultants as necessary to improve performance.

Prepared plans and specifications for capital projects of landfill gas recovery system such as refractory, blower, and pumping system replacement.

Designed and supervised construction of additional pumping system for truck wash to increase performance.

Designed and supervised construction of wash-water filtering system on truck wash.

Responsible for groundwater monitoring programs at operational and closed landfills including sample collection, well placement and construction.

Made recommendations and prepared specifications for the procurement and usage of landfill and recycling center vehicles and heavy equipment.

Waste Resources System Engineer – 8/23/03 to present (City of Chattanooga)

Responsible for maintenance, operation and repair of the City of Chattanooga's gravity sanitary sewer system.

Responsible for flow monitoring and mapping of sewer system.

Develops and implements budgets and monitors expenditures.

Administers repair and line cleaning contracts.

Supervises Sewer Maintenance and Inflow/Infiltration crews.

Review and approve/disapprove new connections to City sewer system by regional users.

Responsible for the establishment of goals, work plans, policies and procedures pertaining to maintenance and operation of the City sewer system.

William C. Payne, P.E.

PROFESSIONAL EXPERIENCE

November 1999-Present *Storm Water Manager, City of Chattanooga*
Oversee administration of the stormwater fee, drainage system design and modeling, and NPDES water quality monitoring and sampling programs. Responsible for \$5 million operational budget.

July 1998-November 1999 *Engineering Project Coordinator, City of Chattanooga*
Designed road widening, streetscape, and curb & gutter projects. Coordinated utility relocation for projects constructed in-house. Calculated cost estimates. Assigned work to design staff. Developed schedule of completion for design work.

December 1995-July 1998 *Engineering Designer, City of Chattanooga*
Designed road widening, streetscape, and curb & gutter projects. Coordinated utility relocation for projects constructed in-house. Calculated cost estimates.

May 1995-December 1995 *Project Engineer, East Tennessee Grading, Inc.*
Responsible for construction of two-foot clay liner and drainage layer at Summit Landfill. Coordinated schedule with general contractor and subcontractors. Performed field moisture tests to determine required soil modifications prior to testing by Inspector.

EDUCATION

B.S. Civil Engineering, University of Tennessee at Knoxville, 1995

PROFESSIONAL REGISTRATIONS

Professional Engineer - Tennessee

PROFESSIONAL ASSOCIATIONS

National Society of Professional Engineers
Tennessee Society of Professional Engineers
American Society of Civil Engineers
American Public Works Association

LEE M. STARNES, P.E.

5318 KELLY'S POINT • OOLTEWAH, TN 37363

423-238-6320

EMAIL: lstarnes@centurytel.net

SUMMARY OF QUALIFICATIONS

Environmental Consultant with expertise in site assessments, project management and business development. Extensive experience in the design and maintenance of remediation systems, storage tanks, spill prevention and response strategies, and corrective action plans. Managed a staff of up to 20 with budgets totaling \$1.5 million. Registered Environmental Engineer (AL, GA & TN).

PROFESSIONAL EXPERIENCE

Golden Gallon, Inc., - Chattanooga, TN

1997 to Present

Manager/Director of Environmental and Petroleum Services

Environmental Manager for a chain of 138 convenience stores/service stations.

- Maintained state and federal regulatory compliance for all aspects of fueling equipment and operations for 138 convenience stores in Georgia and Tennessee.
- Supervised virtually every aspect of UST systems, including: regulatory compliance for approximately 550 USTs, removal and closure of numerous UST systems, design and installation of new UST systems, upgrades to various components on UST systems such as dispensers, STPs, piping, sumps, automatic tank gauges (ATGs) and cathodic protection, compliance inspections and record audits in Georgia and Tennessee.
- Installed the installation of approximately 40 impressed current corrosion protection (ICCP) systems on older UST systems and performed three-year performance surveys. Installation of these ICCP systems offset the replacement of these UST systems for a savings of over \$2 million.
- Led spill responses at all locations which included containment and cleanup various gasoline, diesel, kerosene, and motor oil surface spills, site management and safety, and interaction with third party cleanup crews, store personnel, customers, police, and fire department personnel.
- Set up in-house system to allow remote polling of ATGs for real time monitoring of UST leak detection and fuel inventories, eliminating over \$100,000 in third party leak detection expenses.
- Managed the permitting, installation and operation of an alternative wastewater treatment system. This system included use of new technology which allowed permitting of a system which in turn allowed installation and construction of a new convenience store.

Environmental Consultant

1996 to 1997

Worked as an independent consultant on a contractual basis. Performed environmental site assessments and audits, and prepared design specifications for various bid packages and proposals.

- Conducted and supervised numerous Phase I and II ESAs for major lending institutions in Tennessee. The Phase II projects involved the drilling and sampling of soil borings and ground water monitoring wells to evaluate the nature and extent of areas of concern identified prior to, or during the Phase I ESAs. The investigations allowed numerous property transactions to be completed with the resolution of environmental concerns.
- Performed an independent evaluation of all projects and receivables for Marion Environmental Co. resulting in the discovery of significant over and under-booked receivables.

AQUATERRA. INC., - Chattanooga, TN

1991 to 1996

Branch Manager/Project Manager

- Conducted Phase I and II Environmental Site Assessments (ESAs); hazardous waste management; impacted soil and ground assessments and remediation; voluntary RCRA assessments and cleanups; and UST removals, installations, closures, release response, investigations, and remedial actions.
- Designed and implemented UST Corrective Action Plans and RCRC/CERCLA voluntary cleanups including pump and treat, soil vapor extraction, in-situ air sparging, and dual phase extraction for remediation of soil and ground water impacted by petroleum hydrocarbons and chlorinated solvents. Additionally, several of these systems required preparation of NPDES and air discharge permits.
- Managed 20 FTEs and an annual budget of \$1.5 million.
- Developed several major clients including Kerr-McGee Petroleum Co. and the State of Tennessee Department of Finance and Division of Underground Storage Tanks. This client development led to over \$1 million in projects. Obtaining State of Tennessee contracts involved preparation of proposals and bid packages, and contract negotiations.

Staff Engineer

- Prepared over 40 Spill Prevention Countermeasure and Control Plans (SPCC) for CONOCO Petroleum in Florida, Louisiana, North Carolina, South Carolina, Tennessee, and West Virginia. This resulted in maintaining CONOCO's environmental compliance with a savings of over \$120,000.
- Developed several clients including Roadway Trucking, Dupree Oil Company and ASTEC manufacturing for over \$500,000 of projects. Projects included subsurface investigations of several sites impacted by releases of petroleum hydrocarbons and chlorinated solvents and the design and installation of various site-specific remediation plans and systems.

ARCO OIL AND GAS COMPANY – Lafayette, Louisiana

1990 to 1991

Engineer

- Prepared a detailed proposal for the dismantling and cleanup of a lean oil gas plant.
- Performed reservoir studies to develop significant offshore (South Pass, LA) oil reservoirs and presented development plans to management.
- Directed a project to replace an aging offshore quarters package. This project involved preparing and presenting a \$2.5 million proposal to ARCO management. The project was accepted saving ARCO over \$3 million.
- Developed testing and reporting procedures according to API Guidelines and Minerals Management Service regulations for all safety devices on the process equipment on a new \$65 million offshore platform.
- Supervised field operations for two producing oil and gas fields in South Louisiana. Assembled and administered a \$1.2 million lease operating budget.
- Planned and directed the dismantling, demolition, cleanup and surface (soil) remediation of several oil and gas production sites, and an out of service gasoline plant. These projects required the identification and removal of petroleum hydrocarbon impacted soil, asbestos, heavy metals, various chlorides, DNAPLs, and naturally occurring radioactive materials. These facilities were closed without delays or expenses resulting in overall savings to ARCO of approximately \$500,000.

ACADEMIC BACKGROUND*Master of Science, Petroleum Engineering, Texas A&M University**Bachelor of Science, Petroleum Engineering, Texas A&M University***CERTIFICATIONS**

Tennessee Professional Geologist #3561

Tennessee Professional Engineer #100844

Georgia Professional Engineer #PE023689

Alabama Professional Engineer #21757

AFFILIATIONS

National Society of Professional Engineers

Association of Groundwater Scientists and Engineers

National Water Well Association

Society of Petroleum Engineers

JERRY W. STEWART, P.E.

455 Moccasin Bend Road
Chattanooga, TN 37405
(423) 757-5026
stewart_j@mail.chattanooga.gov

EDUCATION

High School Diploma, 1964

Petal High School, Petal Mississippi

Pre-Engineering Studies, 1964-1966

University of Southern Mississippi, Hattiesburg, Mississippi

B.S. Civil Engineering, 1969

Mississippi State University, Mississippi State, Mississippi

M.S. Environmental Engineering, 1970

Mississippi State University, Mississippi State, Mississippi

Wastewater Operator Short course Certificate, 1986

California State University-Sacramento, Sacramento, California

EXPERIENCE

City of Chattanooga, 7/2001-Present

Director, Waste Resources Division, Department of Public Works

- Responsible for the management, operations, and maintenance of the Interceptor Sewer System, City Landfill, and Wood Recycling Center
- Responsible for 150± employees and O&M budget of \$20 million±

City of Chattanooga, 7/1990-7/2001

Plant Superintendent, Waste Resources Division

- Responsible for the management, operations and maintenance of the 140mgd Moccasin Bend WWTP, 61 wastewater pump stations, 6 storm water pump stations, and 6 CSO facilities (2 are under construction)
- Responsible for 63± employees and an O&M budget of \$11.5 million±
- Scheduled work of employees; coordinated work of on-site contractors; coordinated with consultants; oversaw and participated in activities involving employees, including interviews and disciplinary activities
- Evaluated new chemicals, equipment and treatment processes; optimization of unit processes
- Responded to customer complaints related to odors; trouble shot problems with variations in incoming wastewater
- Coordinated with and prepared reports for regulatory agencies
- Coordinated mechanical, electrical, ground and building maintenance at plant and other facilities; and developed specifications and plans for assigned projects

City of Chattanooga, 5/1985-7/1990

Assistant Superintendent-Operations, Waste Resources Division

- Responsible for the management and operations of the 65mgd Moccasin Bend WWTP and 30± wastewater pump stations, and 4 storm water pump stations
- Scheduled work of employees; oversaw and participated in activities involving employees, including in-house training programs, interviewing, and disciplinary activities; coordinated with consultants
- Evaluated new chemicals, equipment, and treatment processes
- Trouble shot problems with variations in incoming wastewater
- Coordinated with and prepared reports for regulatory agencies
- Coordinated buildings and grounds maintenance for plant and pump stations; and developed plans and specifications for assigned projects

Hensley-Schmidt, Inc., 9/1970-5/1985

Project Engineer and/or Project Manager on City of Chattanooga projects

- Start-up engineer on 1970 Moccasin Bend WWTP plant expansion to 42mdg secondary treatment process
 - Assisted city personnel with start-up activities and optimization of new unit processes; assisted with the collection and analysis of data
 - Coordinated on-site activities of process suppliers and city personnel; developed plant O&M manual
- Project Engineer on area wide 201 Wastewater Facility Plan for the Chattanooga-Hamilton County Tennessee-Georgia planning area
 - Field engineer in charge of 500 industry industrial waste survey. Included sampling of 130± discharges. Prepared report
 - Field engineer in charge of process pilot studies for proposed upgrade of Moccasin Bend WWTP. Pilot studies included the high purity oxygen activated sludge process, rotating biological contractors, and filter presses. Supervised waste characterization studies on influent wastewater to determine oxygen transfer rates and toxicity to biological nitrogen removal
 - Assisted in the writing of the engineer design report for the expansion of the Moccasin Bend WWTP to 65mdg high tech secondary treatment process
 - Prepared O&M manuals for liquids and solids expansion of Moccasin Bend WWTP to 65mdg
- Project Engineer responsible for performing annual field inspection of all ISS facilities for bondholders
- Project Manager for Phase I and Phase II Chattanooga-Hamilton County solid waste to energy studies
 - Duties included field collection of solid waste generation rates and solid waste characterization studies
 - Coordinated and prepared reports

Other

- Project Engineer involved in wastewater sampling and characterization studies for acquiring NPDES permits for numerous industrial clients
- Project manager involved in developing solid waste management plants for St. Tammany Parish, LA

- Project Manager involved in collection of solid waste generation rates and characterization for New Orleans, LA Metropolitan planning agency

AFFILIATIONS

Water Environment Federation: Kentucky-Tennessee Water Environment Association

- President 1996
- Board of Directors 1992-1997
- Quarter Century Operator Clubs Committee
 - Chair -1997 - President
- KY-TN 5-S Committee
 - Chair - 2001
- Local Awards Committee
 - Co-Chair - 2001-Present
- Membership Committee - 1990-Present
- Local Arrangement Committee
 - Co-Chair - 1990

Tennessee Water and Wastewater Association

- Chairman Lower East Section - 1993-1994
- Board of Directors
- Awards Committee Chairman

Tennessee Water Quality Management Association

- Awards Committee

Hixson Kiwanis Club

- President - 1980
- Secretary - 1995-2000
- Board of Directors
- Lt. Governor Division 3, Kentucky-Tennessee District, Kiwanis International 1981

AWARDS

Kentucky-Tennessee WEA

- WEF Hatfield Award for Operating Wastewater Plant - 1996
- WEF Bidell Award for Service to the association - 1998
- 5-S Society for Service to the Association - 1990
- S. Leary Jones Hall of Fame Award - 2000
- Quarter Century Operators Club - 1996

Tennessee Water and Wastewater Association

- M.L. Brickey Award - Contributions to Wastewater field - 1988

Tennessee Water Quality Management Association

- Outstanding Service to Wastewater Field - 1996

David A. Wilson E.I.T.

PROFESSIONAL EXPERIENCE

1999 to present	Sewer Engineering Specialist	City of Chattanooga, Tennessee
1986 to 1999	I & I Rehabilitation Engineer	City of Chattanooga, Tennessee
1984 to 1986	Plant Operating Engineer	City of Chattanooga, Tennessee

EDUCATION

B.S. Civil Engineering, Tennessee Technological University, 1984

PROFESSIONAL REGISTRATIONS

Engineer in Training - Tennessee
Collection System Operator Class II - Tennessee
Waste Water Treatment Plant Operator Class IV – Tennessee

PROFESSIONAL ASSOCIATIONS

National Society of Professional Engineers
American Society of Civil Engineers
Water Environment Federation