



Technical Specifications

Pinery Water & Waste Water District | Douglas County, CO

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Technical Specifications Part 100

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100 AUTHORITY

The Standard Specifications are promulgated by Denver Southeast Suburban Water & Sanitation District (d.b.a.: Pinery Water and Wastewater District). The interpretation and enforcement of the Specifications is hereby delegated to the District Manager or Representative.

101 EFFECTIVE DATE OF SPECIFICATIONS

The Specifications shall be in effect immediately upon formal adoption by the District and shall supersede all former standard specifications for water and sewer construction.

102 REVISIONS, AMENDMENTS OR ADDITIONS

The Specifications may be revised, amended or added thereto. Such revisions, amendments and additions shall be binding and in full force immediately upon formal adoption by the District.

103 PURPOSE

These specifications consisting of Sections 100 through 400 and related construction details and standard notes are intended to govern all water and wastewater design and construction activities within the Pinery Water and Wastewater District for both public and private facilities, which connect to the District system. Water and sewer systems located within buildings shall be governed by the appropriate plumbing and building codes adopted by Douglas County and shall be under County jurisdiction. The technical specifications shall be used in conjunction with the District's Rules and Regulations. Where references are made to the technical or regulatory publications, they shall be accepted as if reproduced in full in these specifications. Definition of terms used shall conform to those in the Rules and Regulations.

104 GENERAL REQUIREMENTS

104.1 New Facilities

All water lines, wastewater lines, and appurtenances within the Pinery Water and Wastewater District shall be designed and constructed in accordance with these Specifications, any deviation from these Specifications shall require written permission from the District, prior to design or construction. Design of all water and wastewater system construction plans shall be performed under the direct supervision of a Professional Engineer, registered in the State of Colorado, and submitted to the District for approval. The size and location of new facilities shall conform to the overall master planning requirements and goals of the District.

Water and wastewater system plan review by the District or construction of the system shall not begin without a signed Developer Service Agreement as determined by the District.

105 PLAN SUBMITTAL AND APPROVAL

105.1 Introduction

This section primarily applies to the submittal requirements for water distribution and wastewater collections systems. Submittal requirements for other infrastructure or unique site constraints and situations may differ from those set forth in this section. A pre-application discussion with District staff is recommended in order to determine the adequacy of submittals made to the District.

Water and wastewater system improvements are required to be designed, approved, and constructed in accordance with the Districts Rules and Regulations, specifications, standard notes and details, and sound engineering principles.

Construction drawings are reviewed by the District for general conformance only and the District assumes no liability for the design or correctness of drawings by others.

105.2 Plan Requirements

The District will not permit construction of a project until all plats, easements, and rights-of-way to be dedicated are fully executed and recorded by the County.

Construction plans for water and sanitary sewer systems shall meet the guidelines set forth in the current Water and Wastewater System Plan Requirements found on the District website. Applicable District details and Standard Notes found on the District website shall be added to the construction plans.

105.3 Format

Plans for public improvements shall be submitted on 24"x36" and 11"x17" sheets as well as PDF in accordance with accepted engineering design procedures. Plans and profiles of all water and wastewater infrastructure are required.

105.4 District Review

Construction drawings, calculations, design information, and other pertinent data shall be submitted to the District for review for all proposed construction. Upon receipt of all required information, the District will review and respond within four weeks. Each subsequent resubmittal will be reviewed and returned within two weeks until the design documents have been approved for construction by the District.

105.5 Approval

Upon approval of the submitted documents, a signed and sealed electronic PDF or full-size paper copy shall be forwarded to the District for approval. Once all approvals have been obtained, two full-size, three half-size, and one electronic PDF shall be provided to the District prior to commencing construction. In addition, one approved full-size plan set shall be maintained on the construction site at all times. District Any project not constructed within one year from the date of approval will be subject to resubmittal.

105.6 Record Drawings

The contractor is responsible for maintaining "as constructed" drawings during construction to show any changes from the plans, additions, deletions, location of buried fittings, locations of services lengths and depths of sewer services and any important notes. The form of record drawings will be discussed with the contractor prior to construction. "As- constructed" drawings supplied to the owners engineer by the contractor shall be checked by the owners engineer and forwarded to the District for review. District Upon District verification the owners engineer shall provide record drawings and associated files consistent with the then current requirements listed in the standard notes available on the District website.

106 INSPECTIONS

106.1 Notification

When any work is anticipated that will impact the water and sewer systems of the District, the contractor responsible for the construction shall notify the District a minimum of seventy-two (72) hours in advance. At the time of the notification the contractor shall advise the District what length of time will be required for construction activities. If working beyond normal working hours or on weekends is desired, prior written approval is required. Work which is anticipated to impact the water and sewer systems of the District will generally not be allowed on weekends.

On a case by case basis, a full- time inspector may be assigned. The cost for such inspections shall be billed to the Developer in accordance with the Developer Service Agreement.

106.2 Material Inspection

All pipe, fittings, and appurtenance shall be carefully examined for defects before installation. Bell and spigot ends of pipes shall be examined with particular care, as these areas are most vulnerable to damage from handling. Defective materials shall be marked by the

inspector and removed from the work site as soon as possible.

As required by the District, pipe and fittings shall be subjected to random testing in order to ensure that the requirements for testing pipe as established by ASTM, AWWA & ANSI standards are met. A reputable testing laboratory, acceptable to the District, shall be chosen and shall select at random for testing up to 2 percent of the number of pipe in each size of pipe furnished, except in no case shall less than 5 specimens be tested. Contractor shall deliver the pipe selected to the testing laboratory, as designated and written test reports will be furnished to the District.

106.3 Construction Inspection

The District's inspector will inspect all new District infrastructure for conformance to the Rules and Regulations and specifications. No work may be backfilled prior to inspector approval. The District will not be responsible for the quality of the work performed by the contractor nor for any defects subsequently found in the work or materials.

107 SAFETY

107.1, General

All construction work performed within the District shall conform to all applicable rules and regulations of O.S.H.A., the State of Colorado and the County of Douglas. When working within public rights-of-way, the contractor shall conform to all applicable traffic control regulations. Contractors are expected to know the necessary safety measures and the District assumes no responsibility for the safety procedures or lack thereof.

108 WATER AND SANITARY SEWER SYSTEM LOCATION AND ALIGNMENT

108.1 General Location in Streets

Where water and sewer lines are located in the street right-of-way, they shall be designed to the following guidelines.

Water and sewer lines shall be located a minimum of six feet (6') off the flow line of the street section. Water and sewer lines shall not cross over the street centerline.

In no case shall District infrastructure be located in cross pans, gutters or sidewalks.

District utilities shall not be located in residential lots.

Lines shall be designed so they will not cross the centerline of the street and shall be kept on the same side of the street throughout the project. Curvilinear sewers are not permitted. A minimum of ten feet (10') horizontal separation shall be maintained between water and sewer lines.

Water lines shall be located to maintain a ninety degree (90°) crossing with sewer lines, and other utilities where possible.

Hydrants shall be located on the same side of the street as the water lines, where possible.

Design of DIP deflections shall be in accordance with the latest edition of AWWA C600 entitled "Installation of Ductile Iron Water Main and their Appurtenances." Design of PVC pipe deflections shall be in accordance with the latest edition of AWWA Manual M23 entitled "PVC Pipe – Design and Installation."

Water main joint deflection for DIP and PVC shall not exceed one half of the manufacturer's maximum allowable deflection for the specified pipe diameter and lay length, or one half of the maximum deflection allowed by AWWA, whichever is less. Fittings, bends, or couplings that allow additional angular offset shall be used to achieve gradual alignment changes that exceed the axial joint deflection limits stated herein.

Where stub-outs are to be provided for service to future areas, the line shall terminate with a main line gate valve or butterfly valve and blow off at the edge of the current development, 10 feet outside of pavement.

108.2 Depth

- Cover over water lines in streets and easements shall be a minimum of five feet (5') and a maximum of six feet (6') measured from the top of pipe to final street or surface grade. These Depths will vary where vaults are to be installed and/or special circumstances deemed appropriate by the District.
- Minimum cover over wastewater lines shall be four feet (4'). The District, on a case-by-case basis, shall review the maximum depth of wastewater lines.
- Wastewater inverts in new developments shall be at required depths to serve the proposed improvements as determined by the designer. The District will not be responsible for sewer depths.

Easements shall have legal descriptions and exhibits prepared in accordance with the District's rules and regulations. Where water and sewer lines are proposed in easements, they shall be designed within the easement boundary to the following minimum requirements. Water and wastewater easements shall be a minimum of twenty feet (20') wide, except that if the sewer line exceeds fifteen feet (15') in depth, the easement shall be thirty feet (30') wide. Where water and sewer lines are in the same easement, the width of the easement shall be thirty feet (30') unless the sewer line exceeds fifteen feet (15') in depth, whereas the easement shall be forty feet (40') wide.

Easement widths are subject to review by the District, larger widths may be required if deemed necessary by the District. When determining the location of the utility in the easement, consideration shall be given to excavation and maintenance and repair requirements. In no case shall the water or sewer line be designed closer than ten feet (10') to any easement boundary.

- Access in easements. Easements shall be designed and maintained for access to utilities by the District. No permanent structures, including but not limited to, trees and branches, rocks greater than two feet (2 ft) in diameter, fences/walls, electrical pedestals, or other above ground features shall be permitted. Landscaping or other improvements shall not be the responsibility of the District and will be removed if necessary. The owner of the land shall agree to hold the District harmless for any loss of property, landscaping or irrigation within the easement area; damaged or removed due to maintenance activities and all associated costs. The maximum cross slope within District easements shall be four percent (4%), and maximum longitudinal slope shall be ten percent (10%).
- All lots shall have a ten-foot (10 foot) utility easement at the front of the lot, this space is to be used for water service infrastructure. These easements shall be indicated on the final plat for all new developments. If the water mainline is located at the rear of the lot, there shall be a ten foot (10 foot) easement to accommodate the waterline service infrastructure in addition to the standard twenty foot (20 foot) easement.

108.4 Easement Legal Descriptions and Drawings

Easement legal descriptions and exhibits shall be prepared under the direct supervision of a Professional Land Surveyor Registered in the State of Colorado, signed and sealed.

Legal descriptions and exhibits shall be referenced to the nearest section corner or other acceptable monument.

Easement exhibits shall be presented at a scale sufficient to clearly show all easement boundaries with bearings and distances. The exhibits shall show the north arrow, referenced section corner, total acres, all dimensions, adjacent property identification, street names, and date of preparation.

Title Insurance Commitment covering the subject easement or right-of-way shall be submitted to the District. A copy of each document listed in the Title Commitment must be included. The Granter shall pay all expenses incurred in obtaining Title Insurance.

The District will not permit construction of a project until all easements and rights of way related to the project are fully signed and recorded by the County.

109 WATER & WASTE WATER LAYOUT AT CREEK CROSSINGS

Where water or wastewater lines are proposed to cross creeks or drainageways, they shall be designed to cross perpendicular. A specific geotechnical investigation shall be performed for each proposed crossing to evaluate potential one hundred-year flood scour depths of the creek or drainageway. After the investigation has been reviewed by the District, minimum depth of the wastewater lines will be established, as well as any erosion protection requirements. Review by the County and Urban Drainage and Flood Control District may be required.

110 UNDERDRAINS

No Underdrains shall be connected to District waste water lines.

111 CORROSION PROTECTION

111.1 Metallic Pipe and Fittings

Corrosion protection consistent with geotechnical recommendations shall be included for the design and installation of all metallic pipes and fittings. Geotechnical reports shall be submitted to the District for review with the first submittal of the construction drawings. Special attention shall be taken for crossings with other metallic lines.

Appropriate test stations shall be included for all corrosion protection systems as determined by the District.

111.2 Connections to Existing Water Systems

Wherever new metallic water systems are proposed to connect to an existing metallic water line, the connection shall be insulated to prevent the passage of electrical current.

111.4 Polyethylene Wrapping

All metallic materials in direct contact with the ground shall be wrapped in accordance with the AWWA C105 specification. The polyethylene shall have a minimum thickness of eight (8) mils. Polyethylene wrapping shall not be stored in direct sunlight. Polyethylene having a "whitish" tone is not acceptable. A two-inch (2") wide, ten (10) mil. thickness polyethylene pressure-sensitive tape shall be used to close the seams and secure to the pipe.

112 **PROTECTION OF WATER SUPPLIES**

112.1 Relation to Other Utilities

Wastewater lines in streets and easements shall be designed to provide a minimum separation of ten (10) horizontal feet from any water line or appurtenance. Horizontal edge-to-edge separation with utilities other than water lines shall be five (5) horizontal feet minimum and shall in all cases allow for future excavation of the sewer line without causing damage to the adjacent utility.

Where wastewater lines are proposed to cross water lines or other utility lines, they shall be designed to cross at an angle close to ninety degrees (90°). Minimum vertical clearance between the edge of wastewater line and edge of the water line or other utility shall be eighteen inches (18").

112.2 Insufficient Pipe Separation

Where a minimum horizontal separation of ten (10') foot or a vertical separation of eighteen (18") inches cannot be maintained between wastewater and water lines, the crossing must be constructed to protect the water line. Minimum protection horizontally shall consist of the installation of an impervious sewer line using AWWA C-900 pipe or concrete encasement.

Where eighteen inches vertical separation is not provided, Installation shall be in accordance with the "CONCRETE ENCASEMENT" detail.

112.3 Concrete Encasements

Concrete encasements shall be constructed to the limits shown on the construction drawings. Should field conditions differ from the approved plans, the encasement limits shall be reviewed in the field by the District prior to construction.

Concrete encasements shall be required under the following conditions:

- Where sewer lines are at a depth too shallow to sustain loads to which they will be subjected.
- At locations where horizontal or vertical movement or loading of the sewer line may be experienced.
- At drainageway or stream crossings where a minimum cover cannot be obtained or as flow conditions in the stream warrant as determined by the District.
- Where vertical separation as required cannot be obtained.
- At any other location designated by the District.

Concrete encasements shall be in accordance with the "CONCRETE ENCASEMENT" detail and shall be of a length to completely span the condition encountered. Concrete shall be adequately vibrated around steel reinforcement. Concrete shall not be placed on frozen or unstable foundation. Suitable concrete protection shall be provided when ambient air temperature is below freezing.

112.4 Pipe Casings

Pipe casing shall be used for bore installations or as required by the District.

112.4.1 Installation

All pipe casings shall be in accordance with the "MAIN IN CASING PIPE" detail.

112.5 Pipe Line Insulation

The District may require that water or sewer lines be insulated from

freezing where cover considerations, bridge crossings, or other special freezing related considerations warrant. The limits of the insulation shall be determined by the District.

112.5.1 Installation

Water or sewer lines shall be insulated in accordance with the "PIPE INSULATION" detail.

Reinforcement steel used in encasements shall be ASTM A36 steel.

113 EARTHWORK

Earthwork shall include all clearing, grubbing, grading, excavation, fill, backfill, excess excavation, bedding material, borrow material, and surface restoration as may be required to complete the work.

113.1 Caution in Excavation

The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground utilities and structures, both known and unknown may be determined. The Contractor shall be held responsible for the repair of such structures when broken or otherwise damaged because of carelessness on his part.

113.1.1 General

Excavation for water, wastewater lines, manholes, fittings and other appurtenances shall be by open trench to the depths required by the Construction Plans.

113.1.2 Limits of Excavation

Length - The maximum length of open trench shall be four hundred feet (400') or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is smaller. The trench shall not be left open when the Contractor has left the project site and is not engaged in construction operations, unless temporary fences or barricades are provided. The Contractor shall place traffic barriers as required.

Width - Trench width at the ground surface may vary with and depend upon the depth, type of soils, and position of surface structures and be in accordance with the District Trench

Detail.

113.1.3 Trenching by Hand

Hand methods for excavation shall be employed in locations necessary to protect existing utilities.

113.1.4 Bracing Excavation

All excavations shall be properly supported in the manner as required by OSHA. The sheeting, shoring and bracing shall be so arranged as to not place any stress on portions of the completed work.

Care shall be exercised in the withdrawing or removing of sheeting, shoring, bracing and timbering to prevent the caving in or collapsing of the excavation faces which are being supported.

113.1.5 Rock Excavation

Solid rock, boulders, and large stones shall be removed to provide a minimum clearance of at least nine inches (9") below the pipe and fittings by mechanical means.

113.2 Tunneling and Boring

Tunneling or boring may be required by the District, County or State Highway Department where construction crosses major roadways. Boring and casing materials and construction methods shall be reviewed by the District on a case-by-case basis.

113.3 Grading and Stockpiling

The Contractor shall control stockpiling and grading in such a manner to prevent water from flowing into excavations and to allow storm water to flow uninterrupted into existing drainage structures. Excavated material shall not be placed or stockpiled closer than two feet (2') from the top edge of the trench.

113.4 Foundation and Subgrade

113.4.1 General

All vault foundations and pipe subgrade shall be stable. Any and all questions relative to foundation and subgrade stability shall be coordinated with the District.

113.4.2 Stable Foundations and Subgrade

The trench bottom shall be excavated six inches (6") below the invert of the pipe unless otherwise designated on the plans.

Before the pipe is laid, the foundation shall be prepared by backfilling with bedding material conforming to these Specifications. The bedding shall be thoroughly tamped. If a suitable foundation is not found additional excavation will be required.

113.4.3 Foundations in Unstable Soil

When excessively wet, soft, spongy, unstable or unsuitable materials are encountered at the surface upon which the bedding material or foundations are to be placed, dewatering shall be performed, and unsuitable materials shall be removed to a depth as determined by the District.

113.5 Dewatering

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 at the bottoms of excavations.

Dewatering of the pipe line trenches shall commence when groundwater is first encountered and shall be continuous until such time that it is safe to allow the water table to rise. Pipe trenches shall contain sufficient backfill to prevent pipe flotation.

The Contractor shall dispose of the water from the work site in a suitable manner without damage to adjacent property or endangering public health or safety. Water shall not be drained into the wastewater system.

All dewatering shall comply with State and County requirements.

113.6 Overdepth Excavation

When excavation is carried below subgrade, approved bedding shall be replaced to provide a firm and unyielding foundation.

Where excavation is inadvertently or otherwise carried below subgrade and/or foundation elevations, bedding material, shall be compacted to one-hundred percent (100%) Standard Proctor Density

to provide a firm and unyielding foundation.

113.7 Bedding

The pipe bedding shall be placed in accordance with the "TRENCH" detail. Bedding material gradation proposed shall be reviewed by the District, prior to initial delivery. Bedding materials and installation shall meet or exceed the requirements of this section. The area from the trench bottom to twelve inches (12") above the pipe shall be referred to as the "pipe zone".

113.7.1 Bedding Material

Pipe bedding shall be clean imported squeegee or gravel conforming to these Specifications.

113.7.2 Class "A" Material

Class A bedding shall be used for the bedding of wastewater lines at depths of cover less than sixteen feet (16'). Class A bedding shall consist of placing select bedding material (known as "squeegee") defined as follows, from six inches (6") under the pipe to a point twelve inches (12") above the top of pipe.

TABLE 14.2 CLASS A BEDDING MATERIAL

Sieve Size	Total Percent Passing by Weight
3/8"	100%
No. 8	65% - 100%
No. 50	10% - 30%
No. 100	0%-10%
No. 200	0%-5%

113.7.3 Class "B" Material

Class B bedding shall be used where designated by the District for trench foundation stabilization. Class B bedding and PVC AWWA C-900 pipe shall be used at depths of cover over twenty- two feet (22'). Pipe strength calculations shall be submitted to the District for review and approval for all such sewer lines.

TABLE 14.3 CLASS B BEDDING MATERIAL

<u>Sieve Size</u>	<u>Total Percent Passing by Weight</u>
1"	100%
3/4"	90% - 100%
3/8"	20% - 55%
No. 4	0% - 10%
No. 8	0% - 5%

113.7.4 Bedding Installation

Accurately shape the pipe subgrade to fit the bottom of the pipe. The intent is to relieve the bell of the pipe from all loading and provide continuous bearing of the pipe barrel on the bedding. Use of a drag template shaped to conform to the outer surface of the pipe will be required if other methods do not give satisfactory results.

The pipe shall be centered in the trench, adjusted to line and grade and bedding shall be simultaneously placed on both sides of the pipe so as not to disturb alignment and grade. The bedding material shall be sliced under the haunches of the pipe to fill all voids. The slicing shall be performed when the bedding material covers approximately one-third (1/3) of the pipe's diameter.

113.7.5 Bedding Compaction

The bedding material, either squeegee or imported sand, shall be compacted by approved methods to a Standard Proctor Density of 90% in open areas (AASHTO T-99) and 95% in all Public right of way (ROW) (AASHTO T-99).

113.8 Backfilling

Trenches shall be backfilled after pipe fittings and appurtenances have been installed and inspected. When a compaction requirement value is specified, the optimum moisture content and density shall be determined in accordance with the appropriate ASTM specification.

113.8.1 Backfill Material

Backfilling shall be done with on-site material, sand or gravel. No oil cake, bituminous pavement, concrete, rock or other lumpy material may be used in the backfill unless these materials are scattered and do not exceed six inches (6") in any dimension.

Material of perishable, organic, spongy, frozen debris or otherwise unacceptable nature shall not be used in backfilling. No material greater than three inches (4") in any dimension shall be placed within one foot (1') of any pipe, manhole or structure.

Backfill material shall be subject to inspection and approval by the District.

All backfill shall also comply with Douglas County Standards.

113.8.2 Backfill Installation

In street rights-of-way and travel zones, the portion of the trench above the "pipe zone" to the finished roadway surface, shall be backfilled and compacted to a Standard Proctor Density of ninety-five percent (95%).- Outside travel zones, compaction shall exceed a Standard Proctor Density of ninety percent (90%).

Backfill shall be placed and compacted per County requirements.

Flooding, pooling, or jetting is not allowed.

113.8.3 Backfill Compaction Tests

Compaction tests shall be taken per County requirements and at locations designated by the County or District. All expenses involved in these tests shall be borne by the Contractor or Developer

No line testing shall be performed until backfill compaction meets the standards set forth herein.

114 CLEAN UP

114.1 Daily Construction Cleanup

During construction, and at the end of each day's work, all affected areas shall be cleaned up and debris which may be displaced by wind will be deposited in an appropriate container or removed from the site.

114.2 Final Cleanup

Upon completion of the work, prior to probationary acceptance, the Contractor shall clean the job-site, street rights-of-ways and easements of all rubbish, unused materials, concrete forms, temporary structures and equipment and other like materials. All excess excavation shall be disposed of and the areas shall be left in a state of order and cleanliness.

All cleanups shall be performed within ten (10) days or an acceptable schedule agreed upon by all parties involved. Cleanup shall be to the satisfaction of the District Inspector.

115 **SURFACE RESTORATION AND MAINTENANCE**

115.1 Paved Surfaced Areas

The Contractor shall obtain the necessary permits to, delete, insert and remove pavement and road surfaces as part of the trench excavation. The width of pavement removed shall meet the standards of the governing agency. The Contractor shall use such sawing method as will assure the breaking of the pavement along straight lines. The cut face of the remaining pavement shall be approximately vertical.

The Contractor shall restore all pavements, sidewalks, curbing, gutters or other surface structures removed or disturbed as part of the work to a condition meeting the standards of the governing agency and shall furnish all incidental labor and materials. No permanent pavement shall be restored until the condition of backfill is such as to properly support the pavement.

115.2 Unsurfaced Areas

All surface cuts shall be, as a minimum required, restored to a condition equal to that prior to construction. All unpaved streets, roadways or rights-of-ways shall be restored in accordance with the regulations and requirements of the agency having control or jurisdiction over the street, roadway, or right-of-way.

115.2 Damaged Surfaces and Property

If any pavement, street, shrubbery, sod, rock, fences, poles or other property and surface structures have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the controlling agency or the specific directions of the District, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired, to original condition and to the satisfaction of the District, at the expense of the Contractor. All restoration shall be performed in a timely manner not to exceed three (3) working days and to the satisfaction of the District Inspector or by a date mutually agreed upon by the District, Owner and Contractor.

116 GUARANTEE

The contractor will be responsible for construction performed, including proper function of the improvement, repair of settled areas, adjustment of pipes, manholes, meter pits, valves vaults and similar items to grade as required and like items for a period of two years from the date of probationary acceptance of the infrastructure by the District. Any malfunction during the period shall be remedied by the contractor to the satisfaction of the District at no expense to the District. If the District is required to make repairs to improvement constructed by the contractor during the two-year period, 110% of the cost of such repairs including engineering, legal and administrative costs will be billed to the contractor.

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SECTION 200 - WATER SYSTEM DESIGN, MATERIALS AND INSTALLATION

201 WATER DEMANDS AND FIRE FLOW CRITERIA

Water lines shall be designed to transport average annual, peak day, peak hour and fire flow demands in accordance with these Specifications. The criteria presented in following Table 2.1 are minimum criteria, and the District reserves the right to modify the criteria, at any time, for the design of specific projects. Water demand criteria for proposed uses not shown in Table 2.1 (i.e. car wash, laundries, auto service stations, supermarkets, places of assembly, hospitals, etc.) shall be determined by the District during system design, on a case by case basis using generally accepted planning criteria.

An allowance for irrigation is included in the residential criteria, however, irrigation is not included in the nonresidential criteria (i.e. commercial, office, restaurant, etc.) and shall be added. Irrigation allowances are shown in Table 2.1. Irrigation should be designed to take place during off peak demand periods. Refer to the latest edition of the District's Rules and Regulations for additional requirements for irrigation design and operation.

The Pinery Water & Wastewater District is within the jurisdiction of the Parker and Franktown Fire Protection Districts. It is the Developer's responsibility to contact the Fire Protection Agency and establish the required fire flow and hydrant locations for each specific project.

**TABLE 2.1
WATER DEMAND CRITERIA**

USE	OCCUPANCY	AVERAGE DAY DEMAND	PEAK DAY DEMAND	PEAK HOUR DEMAND
Single-Family	3.2 Persons	167 GPCD	600 GPCD	1028 GPCD
Town Home	2.5 Persons	167 GPCD	600 GPCD	1028 GPCD
Multi-Family	1.7 Persons	167 GPCD	600 GPCD	1028 GPCD
Commercial	N/A	0.5 GPD/SF	1.06 GPD/SF	2.14 GPD/SF
Office	N/A	0.15 GPD/SF	0.35 GPD/SF	0.71 GPD/SF
Elem. School	700 Stu./Staff	20 GPCD		
Middle School	1070 Stu./Staff	25 GPCD		
High School	2470 Stu./Staff	35 GPCD		
Irrigation	N/A	2.42 ACFT/AC/YR (1"/wk for 29 wks)		

ABBREVIATIONS

Ac-Ft/Ac/Yr	Acre Feet per Acre per Year
GPCD	Gallons Per Capita Per Day
GPD/SF	Gallons Per Day Per Square Feet Developed Floor Area
Multi-Family	Attached Single-Family Residential Dwelling (Rented)
N/A	Not Applicable
SF	Square Feet Developed Floor Area
Single-Family	Detached Single-Family Residential Dwelling (Owned)
Stu.	Students
Town Home	Attached Single-Family Residential Dwelling (Owned)
SFE or ERU	Single Family Equivalent or Equivalent Residential Unit

202 WATER SYSTEM HYDRAULIC DESIGN CRITERIA

202.1 General

All water lines shall be designed to transport water during average and peak demand conditions in accordance with these Specifications, and the District's line shall be less than six inches (6") in diameter. The minimum main size shall be eight inches (8") in diameter to any fire hydrant tee, if the main includes a fire hydrant. Water systems shall be looped systems, where practical, and shall provide a level of service consistent with the Pinery Water & Wastewater District and appropriate Fire Protection District Standards. A maximum of 12 lots are allowed on dead-end water mains in cul-de-sacs.

202.2 Maximum Headloss Criteria

The maximum allowable headloss for water lines is shown in Table 2.2.

**TABLE 2.2
MAXIMUM ALLOWABLE HEADLOSS**

PIPE SIZE	MAXIMUM ALLOWABLE HEADLOSS PER 1000 FEET OF PIPE
6"	2.0
8"	2.0
12"	2.0
16"	1.5
20"	1.5
24" & larger	1.0

Hazen-Williams "C" factor = 130

202.3 Peak Demand Conditions

A variety of peak demand or critical demand conditions exists for different types of developments. Peak conditions shall be reviewed by the designing Engineer with the highest demand condition being used to size water lines. Some typical peak demand conditions include: peak hour demand and peak day demand plus fire flow.

202.4 System Pressure Requirements

Static pressures within the water system shall range from a minimum of 45 to a maximum of 105 psi.

Minimum 45 psi - Maximum 105 psi. Pressures outside this range will be reviewed.

During peak day plus fire flow demand conditions, the residual pressure at any fire hydrant shall be 20 psi, minimum. The maximum allowable pressure fluctuation between average demand conditions and peak hour demand conditions shall be 30 psi.

Where static water pressures exceed 80 psi, individual pressure reducing valves shall be installed on water services, as required by the Uniform Plumbing Code (UPC).

202.5 Minimum Design Pressures

Minimum design working pressure shall be 150 psi. Minimum design transient or water hammer pressure shall be: 120 psi for six inch (6") and eight inch (8") diameter lines, 110 psi for twelve inch (12") diameter lines, and 70 psi for sixteen inch (16") and larger diameter lines. Pipe design calculations shall be submitted to the District, upon request.

203 WATER LINE MATERIALS AND INSTALLATION

All water system materials, construction and testing shall be in accordance with these Specifications. Any material proposed as "an equal" must be reviewed and found acceptable by the District prior to design or construction.

All materials utilized shall be new and undamaged.

203.1 Pipe Classes

Polyvinyl Chloride Pipe (PVC) is the pipeline material preferred for use for all sizes of lines in water systems within the Pinery Water & Wastewater District. It shall be used for pipelines six inches (6") through twelve inches (12") in diameter, and shall be designed in accordance with the UNI-BELL "Handbook of PVC Pipe," latest edition. Tracer wire shall be laid with all PVC pipe. The type of pipe for distribution mains, larger than twelve inches (12") in diameter, shall be determined by the District on a case-by-case basis.

203.1.1 Polyvinyl Chloride Pipe (PVC) - AWWA

Materials

All polyvinyl chloride pipe (PVC) furnished under these Specifications shall be manufactured in strict accordance with AWWA Standard Specifications C900, latest revision, with the following additional requirements:

Thickness Class

Pipe furnished under this Specification shall be a minimum of Class 150, SDR 18. Where system pressures warrant, the District shall require Class 200, SDR 14 PVC pipe or AWWA C151, Class 52 ductile iron pipe. The system working (static) pressure must not exceed the derated pipe pressure class.

235 psi (DR 18), 305 psi (DR 14)

Joint Type

Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint. Solvent welded joints are strictly prohibited.

CU - UF 12AWG Solid Copper with 60 MIL insulation thickness

Tracer Wire

Tracer wire shall be installed on all PVC pipe. The tracer wire shall be 12 gauge solid copper insulated wire. Tracer wire shall be installed in accordance with the "Tracer Wire" detail.

203.1.2 Ductile Iron Pipe (DIP) AWWA

Materials

Ductile iron pipe furnished under this Specification shall be manufactured in strict accordance with AWWA Standard Specifications C150/A21.50, C151, C111, and C104, latest revision, and shall conform with the following additional requirements:

Thickness Class

Pipe thickness class shall be Class 50, unless otherwise specified by the District.

Cement Mortar Lining

All pipe shall have standard thickness of cement mortar lining in accordance with AWWA C104.

Polyethylene Wrapping

Pipe furnished under this Specification shall be polyethylene wrapped in accordance with AWWA C105.

Joint Type

Ductile iron pipe joints shall be "push on joint single gasket," "mechanical joint single gasket", or "restrained joint single gasket" and conform to the requirements of AWWA C 111 latest revision.

203.2 Water Line Installation

General

The interior of the water pipe shall be cleaned of all dirt and superfluous materials of all description as the work progresses.

When pipe laying is not in progress, the open end of the pipe shall be closed with a tight fitting cap or plug to prevent the entrance of foreign matter into the pipe.

Material Review Before Installation

All pipe and fittings shall be carefully examined for cracks and other defects before installation. Spigot ends shall be examined with particular care as this area is the most vulnerable to damage from handling. Defective pipe or fittings shall be set aside.

Laying of Water Pipe

Placement of PVC pipe in the trench shall conform to ANSI/AWWA C605-94 and these Technical Specifications. Placement of Ductile Iron pipe in the trench shall conform to ANSI/AWWA C600 and these Specifications.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot install the pipe without getting earth into it, the District shall require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size, or plastic caps, be placed over each end of the pipe. The bag or caps shall be left in place until the connection is made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed inside the pipe.

As each length of pipe is placed in the trench, the spigot end shall be centered in the bell or coupling and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with bedding material.

Pipe shall be laid with the bell or coupling ends facing the direction of laying, unless otherwise specified by the District.

Alignment and Grade

The water line shall be laid and maintained to the required lines and grades as shown on the construction plans.

Water lines laid on curves shall maintain uniform joint deflection. Short lengths shall not be used. Bends shall be used whenever individual joint deflections would otherwise exceed those specified by the manufacturer.

Laying Lengths

Pipe shall have a normal laying length of eighteen feet (18') or twenty feet (20'), manufacturer's full length of pipe.

Pipe Cutting

All cuts shall be straight and true, done in a workmanlike manner to provide a smooth end, perpendicular to the axis of the pipe and without damaging to the pipe or pipe lining. Remove burrs from the ends of the pipe.

Deflection at Joints

The amount of deflection allowed per joint shall not exceed that specified by the pipe manufacturer. Correcting horizontal or vertical alignments during construction using deflected joints requires District approval.

203.3 Fittings

Materials

All bends, tees and other fittings shall be manufactured in accordance with the following AWWA Standards: C104, "Cement-Mortar Lining for Ductile-Iron Pipe and Gray-Iron and Fittings for Water," C110, "Gray-Iron and Ductile-Iron Fittings, 3-Inch Through 48-Inch for Water and Other Liquids," C111, "Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings," C153 "Ductile Iron Compact Fittings, 3-inch through 16-inch, for Water and Other Liquids," with the following additional requirements or exceptions. The use of "wye" fittings is not permitted.

Linings

All fittings shall be furnished with a cement-mortar lining of standard thickness as defined in the applicable AWWA specifications and shall be given a seal coat of bituminous material.

Type of Joints

All fittings shall be furnished with mechanical joint ends conforming to the referenced AWWA specifications, and in addition, the tee-head bolts and hexagon nuts shall be fabricated from a high-strength, low alloy steel such as "Cor-Ten," "USAlloy," or equal.

Thickness Class

All fittings shall have a 250 psi pressure rating and shall conform to the dimensions and weights shown in the tables of referenced specifications.

Polyethylene Wrapping

All fittings and restraint systems shall be wrapped in accordance with the AWWA C105 specification. Polyethylene wrapping shall not be stored in direct sunlight. Polyethylene having a "whitish" tone is not acceptable.

203.4 Connections

203.4.1 Mechanical Joints

Materials

Mechanical joints furnished under this specification shall conform to ANSI/AWWA C111/A21.11 and shall consist of (1) a bell that is cast integrally with the pipe or fitting, provided with an exterior flange having bolt holes or slots and a socket with annular recesses for the sealing gasket with the plain end of the pipe or fitting, (2) a pipe or fitting plain end, (3) a sealing gasket, (4) a follower gland incorporating a restraint mechanism.

Glands shall incorporate a restraint mechanism, have an asphalt coating unless otherwise specified and shall have cast or the manufacturers identification, nominal size, and letters "DI" or word ductile if made of ductile iron, stamped on them.

The dimensions of the bell, socket, plain end and gland lip and the diameter and location of the bolt holes shall be gauged at sufficient intervals to ensure proper seal and operation of the connection.

Installation

Surfaces shall be cleaned thoroughly to remove all loose rust and foreign material prior to assembly. Lubrication shall be applied to both the gasket and the plain end just prior to slipping the gasket into the plain end and assembling the joint.

Bolts located one hundred eighty degrees (180°) from each other shall be tightened evenly, and alternately with a torque limiting wrench to produce an equal pressure on all parts of the gland until all bolts are within the range of torque's specified by the manufacturer.

If effective sealing is not attained at the maximum allowable torque, then the joint shall be disassembled, thoroughly cleaned, re-lubricated and reassembled.

203.4.2 Flange Joints

Materials

Flanges furnished shall conform to ANSI/AWWA C115/A21.15-83, or latest revision and shall be minimum class 125 per ANSI B16.1. Pipe threads shall conform to ANSI B2.1. Flange facings shall have shallow serration's. Flange joints are not acceptable for below ground installations with the exception of the tapping sleeve valve.

Flanges shall be designed to use a one-eighth inch (1/8") thick rubber full face gasket. Bolts shall be manufactured from low carbon steel conforming to ASTM A307 Grade B and shall have hex heads. Nuts shall have heavy hex nuts and be threaded per ANSI B1.

Installation

Both flange and pipe threads shall be clean prior to application of thread compound. The thread compound shall provide adequate lubrication and sealing properties to provide pressure tight joints.

Flanges shall be fitted so that the contact faces bear uniformly on the gasket.

Bolts shall be tightened evenly, maintaining approximately equal distance between flange faces at all points around the connection. Bolts shall be tightened to within the torque range specified by the manufacturer. If effective sealing is not attained at the maximum allowable torque, then the joint shall be disassembled, thoroughly cleaned, adjusted and re-assembled until proper sealing is attained.

203.4.3 Insulated Connections

General

Insulated connections shall be provided at locations specified by the District to insulate against the passage of electrical current.

Flanges

Insulated flanges, where required, shall have bolt holes three-sixteenths inch (3/16") diameter greater than the bolt diameter. Insulating gaskets shall use full face gaskets with one piece sleeves and double washers.

Mechanical Joints

Mechanical joint connections requiring insulation shall be provided when required.

Testing

Once the insulated joint installation is complete, the Contractor shall perform a resistance test across the joint. The resistance shall be not less than 10,000 ohms.

203.5 Pipe Joint Restraint

All mechanical joints require a follower gland incorporating a restraint mechanism. All horizontal bends, vertical bends, tee branches, reducers, dead-end plugs, valves, and other appurtenances identified by the Engineer or the District, shall be restrained in conformance with the "Pipe Joint Restraint " detail.

Materials

Concrete trust blocks shall be used in addition to other restraints at bends, branches of tees, plugs, caps, fire hydrants and blow-off hydrants.

Pipe restraint shall be accomplished with the use of a proprietary mechanical joint restraint system as manufactured by EBBA Iron, Inc., or equal.

Installation

The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain.

The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2 for ductile iron pipe and at least 150 psi with a safety factor of 2 for PVC pipe. The restraint mechanism shall be wrapped and installed in polyethylene in accordance with these specifications.

Restraint Lengths

The "Length of Restraint" table found on the "pipe Joint Restraint" detail shows minimum restrained lengths for fittings of various sizes. The minimum restrained lengths are based on an internal working pressure of 150 psi plus surge pressures and refers to the minimum length of the pipe which must be "tied" together, and does not necessarily refer to the length of the restraint required.

203.6 Line Valves

Line valves are required at the following locations to provide for effective use and maintenance of the water system. Valves on six through twelve inch (6" -

12") diameter lines shall be direct bury gate valves. Valves on sixteen inch (16") diameter lines and larger shall be direct bury butterfly valves.

Location

Line valves shall be located:

- A) No more than 12 lots will be out of service.
- B) At street intersections on extended property lines.
- C) At creek crossings or other special installations to provide for isolation of the system in the event of a line break.
- D) At other locations designated by the District.

203.6.1 Gate Valves

Material

Valves on six inch (6") through twelve inch (12") diameter lines shall be direct bury resilient seated gate valves.

Direct bury gate valves shall be resilient seated, gray or ductile iron bodied, fully bronze mounted with non-rising stem. Gate valves shall conform to AWWA C509 (resilient seated), latest revision, with a minimum working pressure of 200 PSI. Valve stem shall seal with two "O" rings, each of which shall be designed as to allow replacement under full line pressure when the valve is in the full open position. Valves shall have two inch (2") square operating nuts and shall open by turning the nut counter-clockwise (left).

End Connections

Buried gate valves shall have mechanical joint ends.

Coating

All interior and exterior ferrous surfaces of the valve shall be epoxy coated in accordance with AWWA C550 or latest revision.

Installation

Gate valves shall be handled in such a manner as to prevent any injury or damage to the valve body or operating mechanism. All joints shall be thoroughly cleaned before installation.

Gate valves and boxes shall be polyethylene wrapped and installed in accordance with these Specifications.

203.6.2 Butterfly Valves

Materials

Valves on sixteen inch (16") and larger water lines shall be direct bury butterfly valves, and shall be designed and manufactured in strict compliance with AWWA C504, except as modified herein. Butterfly valves shall be Class 150 B and shall be suitable for service involving

long periods of inactivity. The maximum static differential pressure across the valve shall be 150 psi. At 150 psi, the valve shall be bubble tight for flows in both directions.

Bolts and hex nuts used on the valve and operator shall be the manufacturer's standard, either fabricated from a low-alloy steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process, in accordance with ASTM Standard A 153, is not acceptable for the threaded portions of the bolts and nuts.

Valve Operators

Valves shall be furnished with manual operators designed and sized to develop output torques for Class 150B operating service and shall be sufficient to seat, unseat and rigidly hold the disc in any intermediate position for the above conditions. In addition, the operator shall be designed for buried service and to operate indefinitely in a fully buried condition.

Operator shall be equipped with a standard AWWA two inch (2") square operating nut and shall open by turning the nut counter-clockwise (left).

All gearing shall be totally enclosed and sealed from ground water. The Contractor shall fill the gear case with lubricant to eighty percent (80%) of full prior to installation. The lubricant shall be formulated for a temperature range of 10°F to 150°F.

The maximum input torque required to fully open or close the valve for Class 150B conditions shall not exceed 150 foot-pounds when applied to the operating nut.

The operator shall be capable of withstanding an overload input torque of 300 foot-pounds at the fully-open or fully-closed position without damage to the valve or valve operator.

End Connections

Buried butterfly valves shall have mechanical joint ends.

Painting

All internal surfaces except finished or bearing surfaces shall be coated with epoxy that conforms to AWWA C550. The surfaces shall be prepared in accordance with the manufacturer's requirements. All external surfaces except finished or bearing surfaces shall be coated with two coats of asphalt varnish, Federal Specification TT-C-494A.

After the above painting is completed, a lubricant compatible with the rubber seal shall be applied to surface of this seal and the mating metal surface to prevent bonding of the two surfaces during shipment and storage. Following application of the seal lubricant, the valve disc shall be placed in a slightly open position for shipment.

Installation

Butterfly valves shall be handled in such a manner as to prevent any injury or damage to the valve body or operation mechanism. All joints shall be thoroughly cleaned before installation. Butterfly valves shall be installed with the valve shaft horizontal and operating nut vertical. All butterfly valves shall be polyethylene wrapped and installed in accordance with these Specifications. valves shall be polyethylene wrapped.

Testing

After shop assembly, each valve shall be given operation and hydrostatic tests in accordance with AWWA C500. Installed valves shall be fully opened and closed and shall be tested simultaneously with the water line in accordance with these Specifications.

203.6.3 Valve Box

Valve boxes shall be the three piece adjustable screw type manufactured by the Tyler Pipe Company series #6860 with #160 oval base, or equal. Valve box covers shall be marked with the word "WATER" and shall have a lip or flange extending into the valve box shaft. No slip-type boxes shall be allowed. The valve box shall be of a design which will not transmit shock or stress to the valve and shall be centered and plumb over the operating nut with the box cover set below the pavement to County requirements.

203.7 Tapping Sleeve And Valve

Where a connection is to be made to an existing water main in service and under operating pressure without interrupting service, a tapping valve and sleeve shall be used.

203.7.1 Tapping Sleeve

Materials

All steel plates used in fabrication of the tapping sleeves shall conform to ASTM Standard Designation A36 or A285, Grade C. Tapping sleeves shall be Ford Model FTSC- (size) -SH or equal.

Flanges

Flanges shall be fabricated from carbon steel, and all dimensions shall conform to AWWA Standard C207, "Steel Pipe Flanges," Class D. Flanges shall be machined to a flat rate with finish of 250 micro-inches or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207, "Steel Pipe Flanges". In addition, the machined face shall also be recessed for tapping valves in accordance with the M.S.S. Standard SP-60.

Gaskets

Gaskets shall be Buna-N (Nitrile) ASTM D2000, the shape and cross-section of gasket shall provide adequate seal for the design pressure. Gaskets shall be shop glued to the groove provided in the body section.

Fasteners

Corrosion resistant bolts and hex nuts shall be Stainless Steel.

Testing Outlet

A three-quarter inch (3/4") NPT by welded coupling shall be attached to the outlet nozzle of each tapping sleeve assembly complete with a three-quarter inch (3/4") square head pipe plug.

Coating

All surfaces of the sleeve shall be clean, dry and free from grease and dirt before coating. All surfaces of tapping sleeve except face of flange, bolts and nuts, shall be given a shop coat of manufacturer's standard coating, 12 mils of fusion applied epoxy. Face of flanges shall be shop coated with a rust preventive compound, such as, Dearborn Chemical "NO-OX-ID," Houghton "Rust-Veto 344," or Rust-Oleum "R-9".

203.7.2 Tapping Valves

Materials

The minimum operating pressure for all sizes shall be 200 psi. Tapping valves shall be manufactured in accordance with the Specifications of AWWA C509, latest revision.

Valve Body

Valves shall be resilient seated, gray or ductile iron body, fully bronze-mounted, with non-rising stem..

Valve Stems

Valve stems shall be threaded so that valves shall open by turning to the left (counter-clockwise). Each valve shall be furnished with a two

inch (2") wrench nut, with an arrow showing direction of opening and the word "OPEN" cast on the nut. Stem seal shall consist of two "O" - Rings, designed to allow for replacement of seal above the thrust collar while the valve is under pressure in the fully-open position.

Bolting Material

Bolts and hex nuts used on the bonnet of the valve shall be manufacturer's standard, either fabricated from a low-alloy steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM Standard Designation A153 is not acceptable for the threaded portions of the bolts and nuts.

Gasket Material

The flat, full faced type gaskets required at the bonnet connections shall be fabricated from compressed asbestos sheet with a rubber compound binder. Use of a homogeneous rubber or vegetable fiber sheet, for fabrication of gaskets, is not acceptable.

Inlet End of Valve

Inlet end of the valve shall be flanged. All dimensions and drilling of this flange shall conform to ASA B-16.1, Class 125, and the face of the flange shall have a machined projection, in accordance with M.S. Standard SP-60, for mating to the machined recess in the outlet flange of a tapping sleeve.

Outlet End of Valve

Outlet end of the valve shall have a standard mechanical joint end conforming to the ANSI A-21.11 (AWWA Standard C 111, "Rubber-Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings"). The tee-head bolts and hexagon nuts shall be fabricated from a high-strength low alloy steel, known in the industry as "Cor-Ten," "USalloy," stainless steel, or equal. Both ends of the valve shall be sealed and covered for shipment, and the mechanical joint accessories shall be packed inside the body of the valve.

Seat Ring Size

Body of the valve and seat opening shall be sized large enough to accommodate the following sizes of shell cutters:

<u>Tapping Valve</u>	<u>Shell Cutter</u>		
<u>Nominal Diameter</u>	<u>Diameter</u>		
4"	3 3/4"	+	1/32"
6"	5 3/4"	+	1/32"
8"	7 3/4"	+	1/32"
10"	9 3/4"	+	1/32"
12"	11 3/4"	±	1/32"

Painting

All ferrous surfaces, exterior and interior, except the seating surfaces of flange faces shall be shop epoxy coated in accordance with AWWA C550. Flange faces shall be evenly coated with a rust preventive compound, such as, Dearborn Chemical "NO-OX-ID," Houghton "Rust-Veto 344," or Rust-Oleum "R-9".

203.7.3 Installation

All tapping sleeve and valves shall be installed in the presence of the District. The tap shall be made with proper equipment at a rate which will not damage the existing line. The Contractor shall provide the District with the tap "Coupon" after tapping. The sleeve shall be installed per the manufacturer's recommendation. All tapping sleeves and valves shall be polyethylene wrapped and installed in accordance with these Specifications.

204 WATER SYSTEM MATERIALS AND INSTALLATION

204.1 PRV Stations

Pressure reducing valve installations (PRV's) are required to control distribution system pressures between different pressure zones. The District shall determine the need for PRV's during review of the Construction Drawings. All required elevations for establishing PRV locations shall be furnished by the design engineer (U.S.G.S. datum) and shown on the overall water plans.

204.1.1 Materials

Pressure reducing valves of three inch (3") or less shall be Cla-Val Model 90G-01AS. Pressure reducing valves four inch (4") or greater shall be Cla-Val Model 690G-01AB with delrin stem sleeves. The pressure reducing valve shall be hydraulically operated with a free floating guided piston having a seat diameter equal to the size of the valve. The valve shall be fully bronze mounted and all packing shall have rubber seals to provide tight closure and prevent metal to metal friction. An indicator rod shall be furnished as an integral part of the valve to show the position of the piston within the valve body. The valve shall be designed to provide an access opening in the valve body for removing the piston and other internal parts without removing the main valve body from the line. The minimum design operating pressure shall be 150 psi.

The valve body, flanges and covers shall conform to ASTM A126, Class B. Bronze castings and internal trim shall conform to ASTM B-62.

End Connections

All valves four inch (4") or greater shall be furnished with flanged ends sized and drilled in accordance with ANSI-B16.1, Class 125. Flanges shall be machined to a flat face with a finish of 250 micro-inches, or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207.

Pilot Valve

The pilot valve, used to control the operation of the main valve, shall be a single seated, diaphragm operated, and spring-loaded. The pilot valve shall be attached to the main valve with piping and isolation gate valves arranged to allow for easy access and for removal of the main valve from the system while the line is under pressure. Normal operating range shall have a range of 15-75 psi unless otherwise specified by the District. A flow strainer shall be provided.

Needle Valve

The needle valve shall be all bronze and included with the main valve to control the piston opening closing travel speed.

Coating

All interior and exterior ferrous surfaces of the valve shall be epoxy coated in accordance with AWWA C550 or latest revision..

Expansion Coupling

Expansion coupling shall be Style FC3 and FC6 standard steel couplings as manufactured by Ford Meter Box Co. and conform to AWWA C219. Gaskets shall be SBR rubber per ASTM D 2000 and couplings shall be epoxy coated. Bolts and nuts shall be Type 304 stainless steel.

Pressure Gauges

Pressure gauges shall be Series 545, stainless steel, brass movement, glycerin filled with a minimum three and one-half inch (3-1/2") diameter face and equipped with a brass one-quarter inch (1/4") NPT lower back mount as manufactured by Ametek, U.S. Gauge Division or equal. The upstream gauge shall read from 0 to 160 psi and the downstream gauge from 0 to 100 psi.

204.1.2 Installation

The pressure reducing valve shall be installed in a pre-cast two-section concrete vault in conformance with the "PRV Station" detail. The base section of the vault shall be placed, then all interior piping constructed and connected to exterior lines before the placement of the top section of the vault is allowed.

Interior piping and appurtenances shall be painted gray before installation of the top section.

Pressure gauge mounting shall be completed after the top section is placed. Gauges shall be mounted on an aluminum bracket and attached to the ceiling of the concrete vault near the access manhole at a location designated by the Owner, and taps shall be made in the water lines at the locations shown on the plan. They shall be piped from the main to the gauges along the vault walls with three-eighths inch (3/8") minimum Type K copper and have a shut-off valve located near the tap.

204.1.3 Testing

The PRV Station shall be pressure tested in accordance with the District's specifications.

204.2 Combination Air Valves

Combination Air Relief-Vacuum Breaker Valves (Combination Air Valves) shall be installed at high points in distribution lines eight inches (8") in diameter or greater, where designated by the District, to control the exhaust or admittance of air into the water system. These valve installations prevent air from accumulating at high points in the system during operation, exhaust large volumes of air when the lines are being filled, and prevents water line collapse due to vacuum when a line is being drained or has broken. The District shall determine where Combination Air Valve are required during review of the Construction Plans.

204.2.1 Materials

Combination air valves shall have cast or ductile iron bodies, stainless steel floats and trim, and shall be designed to operate under a maximum working pressure of 150 psi. Combination air valves shall be Val-Matic Model 202C or equal.

All pipe and fittings in the system shall be brass, and all connections shall be threaded.

The corporation ball valve used to isolate the air/vacuum valve assembly shall be a brass valve as manufactured by Ford, Model FB400-7 or equal.

Painting

All surfaces of the valve shall be clean, dry and free from grease before painting. All exterior and interior surfaces, except the stainless steel

trim and the seating surface of the flange face shall be evenly coated with a suitable rust inhibiting primer, or a black asphalt varnish.

Vent Pipes

Vent pipes shall be provided in vaults for ventilation, as shown on the construction details. In residential areas vents shall be decorative aluminum style per the District's "Residential Vent Assembly" detail. In industrial and open space areas vents shall be galvanized iron pipe per the standard detail. Vents shall be located within the street right-of-way or easement boundary at a location acceptable to the District. Exposed surfaces shall be painted a dark green or black.

204.2.2 Installation

The air/vacuum valve shall be installed in a pre-cast concrete manhole structure in conformance with the "Air & Vac Valve " detail.

204.2.3 Testing

Each assembled valve shall be given a hydrostatic shop test two times greater than the rated operating pressure. During the test, air shall be injected into the body chamber of the valve to check its ability to release entrained air to the atmosphere under operating pressure.

After installation, during filling of the line, the air/vacuum valve shall be observed to show that air is being released from the system.

204.3 Fire Hydrants

Hydrants shall be installed in accordance with the "Hydrant Assembly" detail. The number and location of fire hydrants in a given area shall be determined by the appropriate fire protection agency. If hydrants are to be installed at locations other than street intersections, they shall be located on property lot lines.

Fire hydrant branch lines shall be set at right angles to the main line. The hydrant shall be set at the end of the branch line and shall face the branch line. With the exception of the base, no horizontal or vertical bends, or reducers shall be used in installing fire hydrant branch lines. Under no circumstances shall any size or type of tap be made on a fire hydrant branch line.

Dead end water lines eight inches (8") in diameter or smaller shall not have more than one fire hydrant connected to it, except as specifically allowed in writing by the appropriate Fire Protection Agency and the District. Dead end water mains with more than one fire hydrant are not allowed unless the appropriate Fire Protection Agency and the District allow so in writing.

Fire hydrants shall be set a minimum of one foot (1') inside the street right-of-way line. Where it is not possible to install fire hydrants in streets, they shall be

located in easements having a minimum width of ten feet (10'), a maximum length of twenty feet (20') and the easement end line shall extend a minimum of five feet (5') beyond the hydrant.

204.3.1 Materials

The fire hydrant shall be American Flow Control (Waterous) 5-1/4" Pacer 250 D.I.

Fire hydrants shall conform to AWWA C502. Hydrants shall have an underground six inch (6") mechanical joint connection, two - two and one-half inch (2-1/2") hose connections, and one four and one-half (4-1/2") pumper connection in conformance with the appropriate local fire protection agency. Threads on the pumper and hose connections shall conform to the requirements of the "National Standard Hose Threads for Fire Hose Couplings and Fittings," published by the Insurance Services Office. Hydrants shall be designed to operate under 250 psi minimum working pressure. Fire hydrants shall be ductile iron with bronze seat mountings and have a traffic breakaway feature incorporated into the barrel and operating shaft at the finished grade elevation. The fire hydrant assembly shall have an auxiliary six inch (6") gate valve on the hydrant lateral which conforms to these Specifications and the hydrant lateral shall be six inch (6") ductile iron pipe. The operator nut shall be National Standard pentagon shape and measure one and one-half inches (1-1/2") from point to opposite flat and shall open by turning counter-clockwise (left) and shop painted yellow.

Fire hydrant guards shall be provided at locations designated by the District.

204.3.2 Installation

Hydrants shall stand plumb with the pumper nozzle facing the street, unless otherwise designated on the approved plans. Centerline of hydrants shall be located eighteen inches (18") behind the sidewalk or flowline of the curb if sidewalks are not planned.

Hydrants shall be set such that the elevation of the breakaway flange is no more than six inches (6"), nor less than four inches (4"), above the finished grade or top of sidewalk. In the event that a hydrant must be raised, a barrel extension kit supplied by the hydrant manufacturer shall be used. When the barrel is raised, the Contractor shall also raise the breakaway coupling on the operating stem to an elevation to match the breakaway flange. The maximum allowable vertical extension shall be eighteen inches.

Each hydrant shall be connected to the main with a six inch (6") branch line controlled by an independent six inch (6") gate valve. A swivel adapter or locked hydrant tee shall be used. Restraint follower glands shall be used in lieu of rodding. The hydrant shoe and main line tee shall be thrust blocked in accordance with these Specifications. Care shall be taken not to plug the weep holes on the hydrant shoe with the polyethylene or thrust block.

A one-third (1/3) cubic yard drainage pit shall be excavated below each hydrant base bend and filled with three-quarter (3/4") crushed rock. An eight (8) mil polyethylene barrier shall be placed over the crushed rock to prevent backfill material from entering.

The hydrant tee, valve, branch line, hydrant shoe and barrel shall be wrapped with polyethylene in accordance with these specifications.

204.3.3 Testing

Upon completion of the installation of the fire hydrants and water main, each hydrant shall be tested for leaks by closing all nozzle caps and turning the operating nut to full open. There shall be no leaks visible from the caps, traffic flange, bonnet or surfacing from the weep holes. Upon completion of the leakage test, the operating nut shall be closed and a cap removed to allow the hydrant to drain. If the hydrant fails to drain, the Contractor shall excavate the hydrant to check and repair the weep holes, if necessary.

204.4 Blow-off Assemblies

A three-inch (3") blow-off assembly shall be provided at all dead-end lines in the District's water system where system looping cannot be constructed. Blow-off assemblies shall be installed in accordance with the "Blow-off Hydrant" detail.

204.4.1 Materials

The blow-off hydrant shall be a Kupferle Eclipse No. 2 Post Hydrant with tamper proof option. The inlet connection shall be three inch (3") mechanical joint connection. The outlet connection shall be one two and one-half inch (2 1/2") NST connection.

204.4.2 Installation

The blow-off shall be installed in accordance with the "Blow-off Assembly" detail. The blow-off hydrant reducer or tee, valve, branch line, hydrant shoe and barrel shall be wrapped with polyethylene in accordance with these specifications

204.4.3 Testing

Upon completion of the installation of the blow-off hydrants and water main, each hydrant shall be tested for leaks by closing the nozzle cap and turning the operating nut to full open. There shall be no leaks visible from the cap, traffic flange, bonnet or surfacing from the weep holes. Upon completion of the leakage test, the operating nut shall be closed and a cap removed to allow the hydrant to drain. If the hydrant fails to drain, the Contractor shall excavate the hydrant to check and repair the weep holes, if necessary.

204.5 Location Markers

Location markers shall be required adjacent to all valves, tees, bends and straight runs in excess of 1,000 feet installed outside of paved roadways to provide a physical reference for field location.

Materials

Location markers shall be in accordance with the "Location Marker" detail. Location markers shall be six inch by six inch by eight feet (6" x 6" x 8').

Installation

The redwood post shall be buried three feet (3') in concrete. The necessary location information routed directly into the location marker as shown on the "Location Marker" detail unless otherwise designated by the District.

204.6 Precast Concrete Vaults/Manholes

Precast concrete vaults/manholes and base beams are used to house pressure reducing valves, air/vacuum valves and related piping. All precast concrete vaults/manholes shall be designed for H-20 traffic loading in accordance with AASHTO specifications.

204.6.1 Materials

All precast concrete sections shall be designed and manufactured in accordance with ASTM C478.

204.6.2 Installation

Manhole sections shall be plumb and set in two rows of flexible plastic joint sealant, such as Ram-Nek, placed continuously around the entire manhole section circumference. Placement of the joint sealant shall conform to the manufacture's recommendations. Manhole steps shall be centered between the inlet and outlet pipes. Manholes shall be constructed with flat tops unless otherwise approved by the District. The access hole shall be rotated to keep the cover as far from the lip of gutter as possible.

Grout where required shall be a non-shrink type applied per manufacture's instructions. Care shall be taken to apply grout within the proper temperature range, and it shall be protected from freezing until set.

Steps

Manhole steps shall be plastic steel reinforced as manufactured by M-A Industries, Part No. PS2-PF or PS2-PFS, in accordance with the detail in these specifications. Plastic steps shall be drilled and set during manhole construction.

Ring and Covers

Cast iron rings and covers shall weigh not less than 400 pounds, and shall conform to ASTM Standard A27. Rings and covers shall be Denver Light Pattern Cast Iron in areas of no vehicular traffic and Denver Heavy Pattern Cast Iron in streets and highways.

Rings and covers shall be set to the final grades shown on the plans or as staked and shall be securely attached to the manhole riser section with a non-shrink mortar and concrete grout collar. In pavement, the rings and covers shall be adjusted to the slope of the pavement with brick or metal wedges set in the mortar. Covers shall be left one-eighth inch (1/8") to one-quarter inch (1/4") below the surrounding pavement. After the rings are securely set in place, covers shall be installed and the assembly shall be cleaned and scraped of foreign materials.

Exterior Coating Material

In high groundwater areas, exterior joints of vault manhole structures shall be coated with a waterproof bituminous membrane, or equal. The membrane shall be applied after the joints are grouted and shall lap each joint a minimum of six inches (6"). The Contractor shall submit material specifications for the bituminous membrane to the District for review prior to construction. The exterior coating shall be applied per manufacturer's recommendations.

Base Beams and Slabs

Where base slabs or base beams are used, the Contractor shall place a minimum of eight inches (8") of one and one-half inch (1-1/2") crushed rock under the base for leveling and structural stability.

Final Grade Adjustments

Final grade adjustments shall be made using a minimum of three inches (3") and a maximum of ten inches (10") of concrete grade rings. Brick courses and steel grade rings are not allowed for vertical adjustment. If the riser section exceeds the vertical limitation, the riser

and eccentric cone section shall be removed and the appropriate sized barrel section added.

205 WATER SERVICES

Stub-ins herein, ("water services") referred to within these specifications means the stub-in from the water main to the water meter in accordance with the District Rules and Regulations 1.7.21. This is the portion owned and maintained by the District.

205.1 General

The service line shall be located five feet (5') up from the property corner unless otherwise noted on the construction drawings. The District Inspector may relocation the service line due to obstacles encountered in the field.

That portion of the service line between the main and the property line shall be in a continuous straight line perpendicular to the main.

The main to be tapped must extend a minimum distance of eight feet (8') along the front lot line of the property to be served.

The service line shall have a minimum horizontal distance of ten feet (10') from any sanitary sewer line.

Service lines shall be of a size which is adequate to supply the requirements of the property being served. The minimum size allowable for a service line shall be three-quarter inch (3/4"). Unless otherwise noted, all residential service lines tapped off the water main are three-quarter (3/4").

205.2 Materials

Service Saddles

The saddles for C900 PVC water mains shall be a Ford S90 with AWWA taper thread or equal. The saddle for Ductile Iron Pipe mains shall be a Ford 202B with AWWA taper thread or equal. Saddles shall be certified 85-5-5-5 waterworks brass.

Corporation Valve

Corporation valves shall be a Ford F1000 with AWWA taper inlet threads and compression (pack joint) outlet for copper service line or equal. Insulated coupling shall be required between the service line and the corporation valve if use on ductile iron mains.

Service Line

The service line shall be copper tubing Type "K", ASTM B88. No coupling shall be allowed from the main to the curb stop valve (if used) or the yoke.

Curb Stop Valve (if used)

The curb stop valve shall be a Ford B44-333 using compression (pack joint) connections or equal.

Curb Box Stop (if used)

The curb stop box shall be a Tyler Pipe 6500 series or equal.

Meter Yoke

The meter yoke shall be a Ford VBHC82-44-33 using compression (pack joint) connections or equal. The inlet valve shall be the "ball" type, the outlet shall be dual cartridge check valve.

Meter

Water meters are installed by the District and as such are not specified here. It shall be noted, that the District uses an electronic meter reading system which requires modifications to the meter pit cover.

Meter Pit

The meter pit shall be twenty-four inch (24") diameter concrete constructed with one twelve inch (12") and one thirty-six inch ring or four twelve inch (12") rings. The top ring of the pit shall be tapered out to accept a standard twenty inch (20") meter pit cover.

Meter Pit Cover

The meter pit cover shall be a Ford W3 constructed of cast iron. The meter pit cover shall be constructed to allow for an inset meter lid. The meter cover shall be pre-drilled with a one and three-quarter inch (1 3/4") hole offset from the center of the meter cover for acceptance of a touch-read disk. A sample of a cover is available at the District.

205.3 Installation

The service installation shall be constructed in accordance with the "3/4" & 1" Residential Meter Setting" detail.

Tapping of the water mains shall not be allowed until the main has passed the bacteriological test. The Contractor tapping the main shall be licensed with the District. Only wet taps are allowed. The Contractor shall show the "coupon" after tapping.

All water services shall be installed with a minimum of four and one-half feet (4 1/2') of cover.

Excavation, bedding and backfilling shall conform to these specification.

All meter pits shall be staked for finish grade if installation precedes construction of adjacent curb or sidewalk. Meter pits shall be set to final grade by the Contractor and verified by the District Inspector. Meters will not be set until pit covers are at acceptable grade.

205.4 Testing

The Corporation valve shall be opened fully and the line flushed through the yoke. The District Inspector shall witness the flush for quantity and pressure. The valve at the yoke shall be shut off, leaving the corporation valve on. The service line from the main to the meter pit shall remain open for a minimum of one hour (1 hr.) to make sure there are no leaks. The District Inspector may require the Contractor to install a pressure gauge at the end of the service line, close the corporation valve and monitor for a minimum of one hour (1 hr.) to verify no leakage.

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301 DESIGN CRITERIA

301.1 FLOW DEVELOPMENT CRITERIA

Sanitary sewer lines shall be designed to transport average and peak sewage flows. Average and peak flow development criteria presented in following Table 2.1 are minimum criteria, and the District reserves the right to modify flow criteria, at any time, for the design of specific projects. Flow development criteria for proposed uses not shown in Table 2.1 shall be determined by the District on a case by case basis.

Peak sanitary sewer flows shall be calculated as follows:

Peak Flow = (Avg. Flow x Peak Factor)

The peak factor is based on the type of sewer line. Sewer lines shall be classified as either lateral, collector, or interceptor depending on the number of units (SFEs) served. Peak factors as shown in the following table shall be used.

Type of Sewer Line	Number of Units (SFEs or ERUs)	Peak Factor
Lateral	less than 100	4.0
Collector	greater than 100 but less than 1000	3.0
Interceptor	greater than 1000	2.5

Infiltration is estimated to be ten percent (10%) of the average flow and is included in the design flows in Table 2.1.

TABLE 2.1 - FLOW DEVELOPMENT CRITERIA

USE	OCCUPANCY	AVERAGE DAILY SEWAGE FLOW
Single-Family	3.2 Persons	100 GPCD
Townhome	2.5 Persons	100 GPCD
Multi-Family	2.0 Persons	100 GPCD
Retail/Commercial	N/A	0.3 GPD/SF
Office	N/A	0.1 GPD/SF

ABBREVIATIONS

GPCD	Gallons Per Capita Per Day
GPD/SF	Gallons Per Day Per Square Feet Developed Floor Area
N/A	Not Applicable
SF	Square Feet Developed Floor Area
SFE	Single Family Equivalent
ERU	Equivalent Residential Unit

301.2 SANITARY SEWER SYSTEM HYDRAULIC DESIGN CRITERIA

301.2.1 Sanitary Sewer Lines

No public sewer shall be smaller than eight inches (8") in diameter. Lines shall be designed to provide peak flow velocities between two feet per second (2 fps) minimum and ten feet per second (10 fps) maximum using Manning's Formula.

The maximum design flow depth at peak flow shall not exceed eighty percent (80%) of the internal pipe diameter.

Hydraulic characteristics shall be calculated for each reach of the sanitary sewer system to show conformance with these Specifications. Table 2.2 outlines minimum and generally acceptable maximum slopes for sanitary sewer lines as follows.

TABLE 2.2

Nominal Pipe Diameter (Inches)	Minimum Slope (Ft/100 Ft)	Maximum Slope At d/D = 0.80 (Ft/100 Ft)
4	2.0	20.0
6	1.0	12.0
8	0.50	10.0
10	0.35	6.0
12	0.25	4.0
15	0.20	3.0
18	0.20	2.0

As flow depth decreases, the allowable maximum slope may also increase, as long as velocities do not exceed ten feet per second (10 fps). The minimum slopes indicated are absolute minimums.

All dead-end sanitary sewer lines shall have a minimum slope of one percent (1%).

A design report shall be submitted which shows average flows, peak flows, and other pertinent information at all changes in sewer size and points of connection to the existing sanitary sewer system as follows:

Q_{PEAK}	Peak Sanitary Sewer Flow (ft ³ /sec)
Q_{AVG}	Average Sanitary Sewer Flow (ft ³ /sec)
V_{PEAK}	Peak Flow Velocity (ft/sec)
V_{AVG}	Average Flow Velocity (ft/sec)
d_{PEAK}	Peak Flow Depth in Line at Point of Connection (inches)
d_{AVG}	Average Flow Depth in Line at Point of Connection (inches)
d/D_{PEAK}	Ratio of Peak Flow Depth to Inside Pipe Diameter
S	Slope of sanitary sewer line (ft/100ft)
n	Manning's "n" = 0.010 for PVC Manning's "n" = 0.013 for other accepted materials
PF	Peak Factor Per Table 2.1
Development	Number and type of total planned units tributary to the point of connection.

Sanitary sewer system layout shall provide a system of lines which generally increase in diameter from higher to lower areas within the basin. Once a line size is increased at any point in the system, it shall not be reduced in size at any downstream location, regardless of available line slope.

302 MANHOLES

302.1 General Designs

Manholes shall be designed to promote smooth, continuous flow between adjacent reaches of sanitary sewer lines. The minimum drop from the incoming (upstream) invert and the pipe invert (out) shall be two-tenths foot (0.2'). Where manholes are designed to collect flows from two or more incoming lines, the design "in" inverts shall be set to keep the largest incoming line (i.e. line contributing the largest flow) lower in the manhole than the other incoming lines. The other, generally smaller incoming line(s) shall enter the manhole a minimum of one-tenth of a foot (0.1') higher than the invert of the largest line. Maximum inside drop from upstream invert to downstream invert shall be twelve inches.

Where new lines are proposed to connect to the District's interceptor lines, [i.e. lines fifteen inches (15") in diameter or greater], the crown of the incoming line shall match the crown of the interceptor.

Manholes shall have a minimum inside diameter of four feet (4').

Sanitary sewer lines shall be designed so the minimum angle between any upstream line and the downstream line is ninety degrees (90°).

302.2 Location

Manholes shall be provided at all junctions, changes in grade, changes in alignment, and dead-end lines. Manholes shall be installed on straight sections of line at distances not greater than four hundred feet (400') for sanitary sewers fifteen inches (15") in diameter or less, and five hundred feet (500') for sanitary sewers eighteen inches (18") in diameter or greater.

302.3 Manhole Size

Manholes shall have a minimum inside diameter in accordance with Table 2.3.

TABLE 2.3 - MANHOLE SIZING

Two Way Manholes

Maximum Nominal Pipe Sizes	Minimum Manhole Inside Diameter
18" or Smaller	4'-0"
21" to 36"	5'-0"

Three and Four Way Manholes

Maximum Nominal Pipe Sizes	Minimum Manhole Inside Diameter
3-Way 8"	4'-0"
4-Way 8"	4'-0"
3-Way 12"	4'-0"
4-Way 12"	5'-0"
3-Way 18"	5'-0"
4-Way 18"	6'-0"

Three and Four way manholes/vaults having a pipe larger than eighteen inches (18") will require a special design.

302.4 Manhole Depth

Where the depth of a manhole is twenty feet (20') or more from cover to invert, an intermediate platform will be required by the District to be located at the midpoint of the manhole in accordance with the "INTERMEDIATE PLATFORM" detail.

Manholes less than six feet (6') from invert to top of cone shall have a flat-top section (in lieu of cone section).

302.5 Grade Adjustment

Grade adjustments shall be made using a minimum of four inches (4") and maximum of ten inches (10") of precast concrete adjusting collars.

In open space areas, manhole rims shall be set four inches (4") above grade to prevent infiltration from surface runoff. Brick or other materials for height adjustment are prohibited.

Manholes located within the 100-year flood plain limits shall have watertight covers. Frames and covers shall extend above the 100-year flood elevation by the depth of the frame.

302.6 Drop Manholes

Drop manholes may be constructed where it is practical to provide a maximum inside drop of twelve inches. Where this is not practical outside drop manholes may be designed and constructed in accordance with "OUTSIDE DROP MANHOLE FOR PIPE 15" OR SMALLER" detail.

Maximum permitted outside drop shall be reviewed and determined by the District on a case-by-case basis.

302.7 Service Connections to Manholes

Service connections directly to manholes are not permitted except at dead-end manholes on cul-de-sacs. Where one service connection is permitted at a dead-end manhole, the design and installation of a service connection at a dead-end manhole shall conform to the "SERVICE CONNECTION TO DEAD-END MANHOLE" detail.

302.8 Traffic Loading

All manhole structures shall be designed for H-20 traffic loading in accordance with AASHTO Specifications.

302.9 Cast-In-Place Concrete Bases

Cast-in-Place manhole bases shall extend a minimum of eight inches (8") below the pipe invert and the overall outside base dimensions shall be 16" greater than the inside diameter of the manhole barrel section. The base shall be constructed of premixed concrete having a twenty-eight day compressive strength of 3,000 psi, minimum. The concrete shall be composed of well-graded, well-washed, aggregate, ranging from sand to gravel one and one-half inches (1-1/2") in maximum diameter.

Only enough water shall be used in the mix allowing a maximum slump of 4". Base reinforcing steel or wire mesh shall be in accordance with the "STANDARD MANHOLE" detail.

Sewer line block-outs shall be set before any concrete is placed and shall be rechecked for alignment and grade after the concrete pour, but before the concrete has set. Inlets and outlets to the manhole shall be located as indicated on the Construction Plans. A rubber water stop gasket w/ stainless steel clamp shall be placed on the pipe stubs-out.

All base deflectors shall be the proper radius and provide a smooth flow transition in accordance with the "BASE AND DEFLECTOR" detail. The concrete base shall be shaped with hand tools and receive a hard steel trowel finish before the concrete sets.

The accumulation of water on the surface of the concrete due to water gain, segregation, or other causes during placement and compacting, shall be prevented as much as possible. Provisions shall be made for the removal of such accumulated water. Under no circumstances shall new concrete be placed in standing water.

When concrete placement is performed during cold weather, the temperature of the concrete mix shall not be lower than 50° F. When concrete is placed during hot weather, the temperature of the concrete mix shall not be higher than 90° F.

When concrete is placed on grade without the use of forms, the ground shall be moistened or other provisions made to prevent the ground from drawing water from the concrete mix.

302.10 Pre-Cast Concrete Bases

Obtain written permission from the District prior to installing pre-cast manhole bases.

Material Specifications for pre-cast bases are as follows:

- Minimum 4000 psi concrete compressive strength within 48 hours of manufacturing using Type II cement.
- All base and barrel sections shall be poured monolithically. Reinforcement shall include #4 bars on twelve inch (12") centers.
- All areas of seam tears, cracks and honeycomb shall be patched and resurfaced prior to final curing.

- Prior to coring the pipe openings and installing the pipe connection boot, all exposed reinforcing shall be coated with coal tar or epoxy paint.
- Pipe boots are to be placed in the cored openings and shall be manufactured by Kor-N-Seal meeting ASTM C-443.
- Manhole steps shall be manufactured by MA Industries, Inc., Model No. PS2-PF 6 or PS2-PFS polymer polypropylene plastic with grade 60 reinforcement
- Benches shall have a 1-inch/foot minimum drop across the manhole.

Place a minimum of six inches of approved bedding material under the structure for leveling and structural stability. Once the base is installed, make the required pipe connections and place pipe bedding.

The void area between the pre-cast invert, benches, and pipe shall be filled with concrete.

Lifting holes shall be filled with non-shrink grout prior to backfilling.

302.11 Pre-Cast Barrel Sections

Pre-cast concrete barrel sections are to be used for all sanitary sewer construction.

Minimum wall thickness shall be as follows:

Inside Barrel Diameter	Wall Thickness
4' I.D. Barrel	5" Wall Thickness
5' I.D. Barrel	6" Wall Thickness
6' I.D. Barrel	7" Wall Thickness

Reinforcement shall be Grade 60 and for circumferential placement shall consist of one line of steel in compliance with ASTM C-478 latest revision.

Concrete shall be cured in a moisture-controlled environment to meet the minimum 3000 psi compressive strength requirement. Use Type II cement.

Manhole sections shall be plumb and set in two rows of flexible plastic joint sealant, such as Ram-Nek, placed continuously around the entire manhole section circumference. Placement of joint sealant shall conform to the manufacturer's recommendations. Manhole steps shall be centered between the inlet and outlet pipes, and the cone section shall be rotated to keep the cover as far from the lip of gutter as possible.

Where high groundwater is encountered exterior joints shall be grouted. Grout shall be non-shrink type applied per manufacturer's instructions. Completed manholes must meet the vacuum test requirements of section 400. Care shall be taken to apply grout within the proper temperature range, and it shall be protected from freezing until set.

302.12 Steps

Manhole steps shall be manufactured by MA Industries, Inc., Model No. PS2-PF 6 made from polymer polypropylene plastic with grade 60 reinforcement. Manhole steps shall not be used to lift manhole sections.

302.13 Intermediate Platforms

Manhole platforms shall be installed in manholes having a depth of twenty feet (20') or more. The use of intermediate platforms will be reviewed by the District on a case-by-case basis. Material requirements and installation shall be in conformance with the "INTERMEDIATE PLATFORM" detail.

302.14 Ring and Covers

Cast iron rings and covers shall weigh not less than four hundred pounds (400 lbs.) and shall conform to ASTM Standard A27. Rings and covers shall be Denver Heavy Pattern Cast Iron in streets and highways.(Neenah R-1306 or equal with lid marked "Sewer").

Rings and covers shall be set to the required grades and shall be securely attached to the manhole riser section with a non-shrink grout collar. In pavement, the rings and covers shall be adjusted to the slope of the pavement with brick or metal wedges set in the mortar. Covers shall be left one-eighth inch (1/8") to one-fourth inch (1/4") below the surrounding pavement. After the rings are securely set in place, covers shall be installed and the assembly shall be cleaned and scraped of foreign materials.

Manhole covers in unpaved drainage ways shall be aluminum with Cam locks.

302.15 Flat Top Cover

Flat top covers shall be used where the distance from the invert bench to the top is less than six feet. Flat covers shall be a minimum of eight inches (8") thick and designed to withstand H-20 traffic loading.

302.16 Exterior Coating In High Groundwater Areas

Exterior of manhole structures shall be coated with a waterproof bituminous membrane, or equal. The membrane shall be applied after the joints are grouted. The Contractor shall submit material specifications for the exterior coating to the District for review prior to construction. The exterior coating shall be applied per manufacturer's recommendations.

302.17 Non-Shrink Grout

Grout for sealing openings in manholes shall be pre-mixed Master Builders "Set Grout" or Sika "Grout 212".

302.18 Pipe at Manholes or Structures

A pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet(s) and/or outlet to each manhole or structure. The joint shall be within two feet (2') of the wall.

Pipe bells shall not be cast into manholes or structures. The bell shall be cut off so that the plain end of the pipe is flush with the inside wall of the manhole or structure.

302.19 Foundations and Subgrade

All manholes or vault foundations and pipe subgrade installation shall be in a stable condition. Any and all questions relative to foundation and subgrade stability shall be coordinated through the District.

303 MATERIALS AND INSTALLATION

All sanitary sewer system materials and construction shall be in accordance with these Specifications. Any material proposed as "an equal" must be reviewed and found acceptable by the District prior to design or construction. PVC pipe material (as defined in Section 312) for sanitary sewer system construction.

303.1 SDR 35 POLYVINYL CHLORIDE (PVC) PIPE

303.1.1 Material

All non-pressurized plastic pipe and fittings shall be polyvinyl chloride (PVC) and shall meet the requirements of ASTM D 1784. "Rigid Poly (Vinyl Chloride) and Chlorinated Poly (Vinyl Chloride) Compounds" and ASTM D 3034 type SDR 35, (sizes 8-inches through 15-inches) or ASTM F 679 SDR 35 (18" through 27"), "Type PSM Polyvinyl Chloride (PVC) sewer pipe and fittings" latest revision. Pipe and fitting markings shall include the appropriate ASTM and Cell Classification Numbers (12454-B or 12454-C or other ASTM approved classifications). Unmarked pipe and fittings will be rejected.

303.1.2 Straightness

Maximum allowable curvature as measured from the concave side of the pipe at the center shall not exceed one-sixteenth inch (1/16") per foot of length (one and one fourth inch for 20').

303.1.3 Joint Type

PVC joints shall be made using an integral bell and spigot type rubber gasketed joint. Each integral bell joint shall consist of a formed bell and a single rubber gasket. Gaskets shall conform to ASTM F-477.

303.1.4 Thickness Class

All PVC pipe shall have an SDR ratio of thirty-five unless otherwise specified by the District.

303.1.5 Laying Lengths

PVC pipe shall have normal laying length of either eighteen or twenty feet (18' or 20').

303.2 AWWA C900 POLYVINYL CHLORIDE PIPE (PVC)

303.2.1 General

AWWA C900 PVC pipe shall be used where the sewer line needs concrete encasement and at crossings with water lines. All polyvinyl chloride pipe (PVC) furnished shall be manufactured in strict accordance with AWWA Standard Specifications C900, latest revision, with the following additional requirements:

An adaptor coupling is to be used with transitions from and to SDR35 and C-900 as specified.

303.2.2 Thickness Class

Pipe furnished under this Specification shall be a minimum of Class 150, SDR 18.

303.2.3 Laying Lengths

Pipe shall have a normal laying length of twenty feet (20'). Random lengths shall not be acceptable.

303.2.4 Joint Type

Pipe joints shall be made using an integral bell and spigot type elastomeric gasketed push-on type joint. Solvent cement joints are strictly prohibited. Gaskets shall conform to ASTM F-477.

303.3 SANITARY SEWER PIPE FITTINGS

303.3.1 Fittings and Branches

In line 45° "wyes" conforming to the same ASTM Specifications as pipe are the only fittings acceptable for service connections for new construction. "Wye" branches shall have their axis 45° above the longitudinal axis of the pipe.

Service connections to existing PVC pipe require the use of a long body style "wye" saddle and rubber gasket secured to the pipe using a solvent weld and double stainless steel straps.

Service connections to existing concrete or vitrified clay pipe require the use of a PVC "tee" saddle and rubber gasket secured to the pipe with double stainless steel straps. The service connection shall be encased in concrete.

303.3.2 Plugs

Pipe plugs shall be three-quarters of an inch (3/4") in thickness and shall have a factory-made plasticized polyvinyl chloride compound joint material cast and bonded to the pipe. The material shall be molded and cured to a uniform hardness and compressibility, and form a tight compression coupling when assembled. The material used for the compression joint shall conform with the type of pipe material. The joint formed by the plug and pipe shall be a water tight compression coupling when assembled.

304 SANITARY SEWER SYSTEM INSTALLATION

304.1 Sanitary Sewer Line Installation

Pipe shall be laid without grade break from structure to structure, with the bell ends of the pipe upgrade. The interior of the sewer pipe shall be cleaned of all dirt and other material of all descriptions, as the work progresses.

When pipe laying is not in progress, the open end of the pipe shall be closed with a tight fitting cap or plug to prevent the entrance of foreign matter into the pipe.

A water-tight plug (Pollard, or equal), shall be installed at the point of connection to the existing system at the start of construction, and shall not be removed until acceptance of the system by the District.

304.1.1 Material Review Before Installation

All pipe, fittings, shall be carefully examined for cracks and other defects before installation. Spigot ends of pipe shall be examined with particular care as this area is the most vulnerable to damage from handling. Defective materials shall be set aside and adequately marked to avoid inadvertent use.

304.1.2 Laying of Sanitary Sewer Pipe

Placement of PVC sanitary sewer pipe in the trench shall conform to ASTM D2321 Specification for "Underground Installation of Flexible Thermoplastic Sewer Pipe", Uni Bell Standard UNI B-5, and these Specifications. Placement of ductile iron sanitary sewer pipe in the trench shall conform to

ANSI/AWWA C600 and these Specifications. Under no circumstances shall PVC sewer pipe be dropped into the trench.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line.

As each length of pipe is placed in the trench, the spigot end shall be centered in the bell or coupling and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with bedding material.

304.1.3 Alignment and Grade

Laser beam equipment or the batter board system may be used to provide line and grade.

When using the batter board system, batter boards shall be installed on each side or on the same side of the trench. Stakes supporting the batter boards shall be placed the same distance apart as the grade stakes. Three batter boards shall be in use at all times. Cross members extending across the sewer ditch shall be set according to the grade showing on the grade stakes. A centerline grade string and plumb-bob shall be used to keep the sewer pipe in line. A grade rod shall be used to provide accurate grade on the invert of the sewer pipe.

304.1.4 Joint Installation

Prefabricated joints used in the laying of sanitary sewer lines shall be jointed using lubricants, primers, adhesives, solvents, etc. recommended by the pipe manufacturer.

304.1.5 Fittings and Branch Installations

Wyes shall be furnished and installed as construction proceeds. Wyes of the size(s) specified shall be installed for all sanitary sewer service connections as shown on the construction plans.

Installation, earthwork and bedding for service connections shall conform to the applicable provisions set forth for the sewer line. Unless otherwise specified, the branch of "wye" fittings shall be inclined upward at an angle not greater than forty-five percent (45°) from a horizontal line. No wye for a sanitary sewer service connection branch may be placed closer than five feet (5'), to the downstream edge of any structure, or three feet (3') from the bell or spigot end of a pipe section. Successive wyes shall be separated a minimum of 3'.

Plugs shall be installed to withstand the internal pressure of the leakage and/or infiltration test; however, installation shall be made in such a manner that always can be removed without injury to the socket.

305 LIFT STATIONS

Lift stations shall be avoided. If required, lift stations shall be designed by a registered professional engineer and design information including construction plans shall be submitted for approval by the District. Design perimeters for lift stations and force mains shall be prepared in conjunction with the District if the facility is to be turned over to the District for operation and maintenance.

306 SERVICE LINES

A separate sewer service will be required for each user of the system. In residential areas the service lines shall be located downstream and approximately 5 feet from the centerline of the lot unless another location is approved by the District. Service lines shall be a minimum of 4" diameter and shall be installed from the main line to the property line at the time of construction of the collection system. Service lines shall generally have a minimum of 6 feet of cover and in no case shall the line be less than 4 1/2 feet deep.

Service lines shall connect to the main in the upper quadrant of the pipe at approximately a 15 degrees to 30 degree angle from the horizontal. Wye branches may be installed during main construction with watertight plugs to permit testing of the sewer main, or tapping saddles may be used. On service lines over 100 feet in length an intermediate clean out shall be installed.

Technical Specifications Part 400

Testing and Acceptance

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401 GENERAL

All water and sewer utilities outside buildings, whether public or private, must be inspected and approved by the District. All public facilities owned by or to be dedicated to the District must conform to the provisions of this section.

Provisions must be made with the District by the contractor for all public water and sewer facilities to be inspected during construction as required. Testing of new facilities will be done by either the contractor or his agent at the contractors expense. Coordination of inspection times will be made with the District and a District inspector will be present during the testing. District inspection of building services must be requested a minimum of 48 hours in advance;

If inspection and/or testing of facilities is required beyond normal District business hours, the contractor or developer will be billed for the cost of inspection above the normal fees assessed.

402 WATER MAINS AND APPURTENANCES

402.1 Testing Prior to Installation

As required by the District, pipe and fittings shall be subjected to random testing in order to insure that the requirements for testing pipe as established by ASTM, AWWA & ANSI standards are met. A reputable testing laboratory, acceptable to the District, shall be chosen and shall select at random for testing up to 2 per cent of the number of pipe in each size of pipe furnished, except in no case shall less than 5 specimens be tested. Contractor shall deliver the pipe selected to the testing laboratory, as designated and written test reports will be furnished to the District. Testing shall be done at Contractor's expense,

All pipe and fittings shall be subject to inspection at the job site or other point of delivery by the District. The purpose shall be to cull any materials that fail to conform to the requirements of the specifications or that may have been damaged during transportation and/or subsequent handling.

The District reserves the right to reject any and all pipe sections that contain visual imperfections or any other imperfections that may be considered detrimental to operation and life of the pipe.

402.2 Disinfection

Mains, stubs, hydrant leads, etc. shall be chlorinated in accordance with ANSI/AWWA C651-92, "DISENFECTING WATER MAINS" prior to the lines being accepted. Disinfection of finished pipelines shall be done prior to leakage testing.

402.2.1 Tablet Method

Chlorine tablets may be used for disinfection in 12-inch diameter or smaller lines when contamination control has been exercised during installation of the pipe because the line cannot be flushed prior to chlorination. The tablet method shall not be used when trench water or foreign materials have entered the water line or the ambient air temperature is below 40 degrees Fahrenheit. Tablets shall be secured at the top of the inside circumference of the pipe wall by use of Permatex #1C or 2C or other approved food grade

adhesive. During installation the pipe shall be marked and care taken to insure that the chlorine tablets are at the top of the pipe. After the water line has been filled, the concentration of chlorine shall be at least 50 milligrams per liter and after it has set for 24 hours the chlorine test concentration shall be a least 25 milligrams per liter. Under normal conditions, the number of tablets as shown in the following table should produce the required concentrations.

NUMBER OF CALCIUM HYPOCHLORITE TABLETS PER PIPE SECTION

Length of Section (Feet)	Diameter of Pipe (Inches)						
	4"	6"	8"	10"	12"	14"	16"
13' or less	1	1	1	2	3	4	4
18'	1	1	2	3	4	5	6
20'	1	1	2	3	4	6	7

While filling the line, the velocity shall be kept at less than 1 foot per second so as not to dislodge the tablets. When the lines are full, operate all valves to ensure thorough chlorination.

402.2.2 Continuous Feed Method

This method shall be used in lines larger than 22-inch diameter, or if it is necessary to flush the water line prior to chlorination, or for re-chlorination if the tablet method fails.

Application of chlorine: Water shall be introduced into the mains from the existing distribution system until they are full and all air has been expelled. Chlorine slurry is then pumped into the line at the source of fresh water at a rate which will result in a chlorine concentration of not less than 25 milligrams per liter. The solution shall be allowed to remain in the system for 24 hours after which the free chlorine residual shall be not less than 10 milligrams per liter measured at various locations. During this period valves shall be operated to insure that sterilization is obtained. Under normal conditions the following table should provide the necessary chlorine residual.

CHLORINE REQUIRED, PER 100 FEET OF PIPE

Pipe Size (inches)	100 Percent Chlorine (Lb.)	1 Percent Chlorine Solution (Gal.)
4"	0.013	0.16
6"	0.030	0.36
8"	0.054	0.65
10"	0.085	1.02
12"	0.120	1.44
16"	0.217	2.60

402.2.3 Special Situations

If it is not possible to totally isolate the section of line being tested from the distribution system, the contractor shall at minimum, swab all added fittings and pipe with a 5 percent Sodium Hypochlorite solution (commercial Clorox or equivalent) or a 350 MG/L available chlorine solution made from Calcium Hypochlorite. Swabbing shall be done just prior to installation. One 5 gram tablet of Calcium Hypochlorite (70 percent chlorine per 10 liters of water is equal to 350 MG/L of available chlorine.

402.2.4 Flushing

After sterilization the entire system shall be flushed until the chlorine residual is less than 1 MG/L. Water lines shall be flushed at a velocity of at least 2.5 feet per second throughout the line and care exercised to prevent erosion or killing of desirable vegetation during the flushing process.

402.2.5 Bacteria Test

Samples of water in the mains shall be obtained by the District or District approved contractor at locations determined by the District, at least one for each section where flushing occurred. Samples shall be submitted to the Colorado Department of health and Environment or to a District approved laboratory for bacteria testing. If undesirable bacteria remain, the main(s) shall be rechlorinated.

402.3 Water Pipe Leakage Test

After the pipe has been installed, visually inspected and backfilled, a leakage test shall be made. The test section shall be slowly filled with water and all air expelled. The maximum elevation difference between the highest and the lowest points in the test section will be 150 feet. If necessary, the contractor shall install corporation cocks at high points, dead ends and other required points to insure total expulsion of air as the line is being filled with water. The District must approve the source and method of supplying water for hydrostatic testing.

Once the line is filled with water, a test pump equipped with a bypass valve for regulating pressure, shall be used to apply test pressure of 200 psi at the lowest point in the section of line under test. This pressure must be maintained for a minimum of one hour.

Leakage is defined as the amount of water that must be supplied to the test section to maintain the specified leakage test pressure after the air in the pipe lines has been expelled. The District will supply the calibrated meter for recording the water loss. No pipe installation will be accepted if leakage is greater than that determined by the formula:

$$L = \frac{ND\sqrt{P}}{8000}$$

This formula is acceptable for mechanical joints and push-on joints on ductile iron and PVC pipe. L is the allowable leakage in gallons per hour; N is the total number of joints in the test section, considering all bends and valves; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the test in pounds per square inch.

Diameter (inches)	Allowable Leakage / 1000' or 50 Joints
6"	0.53 GPH
8"	0.71 GPH
10"	0.88 GPH
12"	1.06 GPH
16"	1.41 GPH

403 SEWER VISUAL/VIDEO INSPECTION

403.1 Visual Inspection

Subsequent to installation and backfilling all sewer lines shall be subject to a visual inspection by lamping or use of mirrors, as appropriate. To be acceptable, a minimum of one half circle of light must be visible between adjacent manholes. Cracked, defective or broken pipes noted during this inspection must be removed and replaced.

If dirt or other debris is encountered during the visual inspection, the entire line shall be flushed and/or balled as necessary to insure it is clean and free of all sand, dirt and debris. During such cleaning no debris will be permitted to be discharged into the existing sewer system.

403.2 Video Inspection

Prior to acceptance of any sanitary sewer line by the District, said line shall be inspected internally by television as outlined below. Defects such as high and low spots, joint separations, offset joints, chipped ends, cracked or damaged pipe, infiltration points and debris in lines shall be corrected by the Contractor. For joint separations, low spots and chipped ends, the following maximum acceptable limits shall apply for 8"-10" pipes:

- Joint separations - none (Manufacture's Specification)
- Low spots - none (near zero tolerance)
- Chipped ends - none (zero tolerance)

For pipe larger than 10", specific maximum limits shall be specified by the District for each project.

- A. The complete job is ready for television inspection when the following work has been completed.
 1. All sewer pipelines are installed and the backfill is compacted.
 2. All attributes are in place, all inverts are complete and pipelines are accessible from structures.
 3. All other underground facilities, utility piping and conduits are installed.
 4. Final air test has been completed.
 5. Vacuum Test has been completed
- B. When the above work is complete the Contractor of the project shall notify the District in writing as to the scheduled date of the television inspection.
- C. The television inspection shall be done using the procedures in section 403.2, Television Inspection Procedures.

- D. The entire job will be televised videotape will be made and defects requiring correction will be noted.
- E. Prior to submittal to the District, the Engineer, Owner and Contractor should review the videotape for any defect that may be visible. If tapes and cut sheets (see appendix) are submitted to the District that are obviously "unacceptable," the Contractor shall be charged at 110% of costs for the time taken by District personnel to review the tape. The minimum charge shall, be \$100.
- F. The Contractor will be notified in writing of any deficiencies revealed by the television inspection that will require repair. If no deficiencies are observed, the work will be considered satisfactory. If corrective work is indicated and the Contractor wishes to view videotapes, he shall contact the District to set a time for the viewing.
- G. Corrective work shall be done.
- H. Those portions of the pipeline system that have been corrected must be retelevised.
- I. The procedure outlined in conditions "A" through "I" above will be repeated until all deficiencies observed by television inspection have been corrected to the complete satisfaction of the District.

403.2.1 Television Inspection Procedures

- A. The Contractor shall provide the District the "original" tapes on VHS format with an audio narrative of the inspection with all footages and locations noted on each tape. District standard cut sheets shall accompany each tape/submittal.
- B. Mains shall be televised with water introduced into the main at the direction of the District's Inspector. Televising shall occur with the direction of flow unless the District's Inspector has given prior written approval.
- C. Submitted tapes shall include:
 - The original tape. Copies will be rejected.
 - The original cut sheets. Copies will be rejected.
 - Footage indicator
 - Running Time
 - Date
 - Location
 - Beginning and ending manhole numbers for each run

403.3 DEFLECTION TESTING

If obvious deflection of pipe in excess of 5 percent of the nominal diameter appears to have occurred during visual inspection, the District may require the contractor to perform deflection testing. This test shall consist of pulling a mandrel through the pipe by hand. No mechanical equipment may be used in pulling the mandrel.

Mandrel outside diameters are shown on the following table:

BASE INSIDE DIAMETERS AND MAXIMUM MANDREL DIAMETERS FOR DEFLECTION MEASUREMENTS OF PVC SEWER PIPE

Size (in.)	Base ID (in.)	Mandrel OD (in.)
8	7.76	7.37
10	9.71	9.22

12	11.56	10.98
15	14.14	13.43
18	17.28	16.42

Pipe with a deflection exceeding 5 percent of the inside diameter shall be uncovered and, as a minimum, the bedding and backfill replaced to eliminate excessive deflection. Repaired pipe sections shall be retested.

403.4 Leakage Testing

Low pressure air testing shall be conducted on all new sewer mains after backfilling operations are complete. Testing shall be conducted in the presence of the District representative. At the discretion of the District infiltration testing shall be used if excessive ground water is encountered.

403.4.1 Low Pressure Air Testing

Contractor shall furnish all necessary equipment and be responsible for conducting air tests. The equipment used shall meet the following minimum requirements:

1. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe being tested and shall resist internal test pressures without the aid of external bracing or blocking.
2. All air shall pass through a single aboveground control panel to facilitate test verification.
3. Three individual hoses shall be used for the following connections
 - A) From control panel to pneumatic plugs for inflation.
 - B) From control panel to sealed line for introducing the low-pressure air.
 - C) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

TEST PROCEDURE - Plugs shall be placed in the line at the manholes, which terminate the reach to be tested, and inflated to 25 psig. Low pressure air shall be introduced into this sealed section of line until the internal air pressure reaches 4 psig greater than the average back-pressure of any ground water that may be over the pipe but no greater than 9.0 psi. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period, the air pressure shall be adjusted to 3.5 psig greater than the average back-pressure of any ground water that may be over the pipe. The air hose from the control panel shall be disconnected. The portion of the line being tested will be acceptable if the time required for the pressure to decrease from 3.5 to 2.5 psig greater than the average back-pressure of any groundwater that may be over the pipe, is greater than the time given by the following formula:

$T = 0.0850 DK / Q$, mins.

Where: $K = 0.000419 DL$, but not less than 1.0

Q = specified rate of loss = 0.003 cfm/sq.ft. of internal surface

D = pipe diameter, inches

L = length of pipe being tested, feet

When $K > 1$, $T = 0.0002D^2 L$, mins.

No sealant may be used in any new sewer construction without the prior approval of the District.

If the section being tested fails to meet these requirements, the Contractor shall determine the source of leakage, at his own expense, and shall repair or replace all defective materials and/or workmanship. The pipe section shall be retested, as necessary, until it meets the requirements.

403.4.2 Infiltration Testing

Should high groundwater be encountered when constructing a section of the sewer between structures, the end of the sewer at the upper structure shall be plugged to prevent the entrance of water, and pumping of ground water shall be discontinued for at least three days after which the section shall be tested for infiltration. The infiltration shall not exceed 50 gallons per day per inch of diameter per mile of sewer being tested and does not include the length of service laterals entering that section. Where any infiltration in excess of this amount occurs, the sewer shall be repaired or replaced and the amount of infiltration reduced to below the allowable infiltration before the sewer is accepted. Should infiltration be less than the allowable amount, the Contractor still must correct any observed leaks. The Contractor shall furnish all labor and materials for making the tests required.

403.5 Manhole Testing

Each manhole within the system shall be subjected to air vacuum testing as described.

403.5.1 Vacuum Testing

Vacuum testing shall be done prior to paving and before setting of rim and cover. Equipment used shall be fabricated to insure an air tight seal at the top of the manhole. Pipe plugs shall be placed in all sewers entering and exiting the manhole. A vacuum of ten inches (10") of Mercury (Hg) shall be pulled and the time recorded for the vacuum to drop to nine inches (9") Hg recorded. The time to drop one inch (1") Hg shall not exceed the following:

TIME FOR VARIOUS MANHOLE DEPTHS (Seconds)

18 Feet or Less

60

Over 18 Feet

75

If the test fails, the contractor shall make necessary repairs and retest until a satisfactory test is obtained. Should gasket material be pulled out during the test, the manhole shall be disassembled and the gasket material replaced.

404 FORCE MAINS

All force mains shall be tested for leakage and shall meet the requirements specified in section 402.3 for water mains.

405 RETESTING

Contractor shall make any necessary repairs and retest to insure conformance with the leakage test requirements.

If any unusual settlement occurs over sections of PVC sewer or force main prior to initial acceptance or during the two-year probation period, the contractor shall be required to re-televisize the lines for potential problems.

406 FINAL MANHOLE INSPECTIONS RING & COVER

406.1 Manhole Final Grade

Contractor must notify the District in writing as to the date when final manhole adjustment rings are to be installed after paving is completed. The District will inspect the process to determine that proper grout is installed to prevent infiltration into sewer system. Final inspection of manhole base for dirt and debris.

406.2 Asphalt Clean up

Paving contractor must clean all asphalt from top of manhole cover and check for proper operation.

407 WATER & SEWER SERVICES

The District will visually inspect all domestic water and sewer services between the main line and property line and the trench must remain open until the inspection is completed.

All service lines must be adequately flushed and the curb stop opened and closed several times to insure that it is working properly.

When required by the District water services shall be tested under available operating pressure for leakage. In such cases the corporation stop at the main must remain accessible until the test is completed. For such test the line will be filled and the corporation stop turned off. A pressure gauge at the end of the service line will be monitored for a minimum of one hour to insure that the line is holding its pressure.

Sanitary sewer services will be inspected for alignment, grade and bedding. The trench must remain open until the inspection has been made.

408 FINAL LINE CLEANING

All new mains must be jetted prior to probation and may be required again prior to final conveyance and acceptance by the District. Costs of jetting will be the responsibility of the Contractor. The Contractor will be responsible for all pumping associated with the line jetting.

409 FINAL FIELD ACCEPTANCE

When all tests required herein have been satisfactorily completed and other conditions for acceptance met the water and/or sewer mains will be conditionally accepted.

At the end of the two-year probationary period a final visual examination will be made of the system including a manhole inspection, testing of valves, operation of hydrants, etc. The route of the lines will be visually inspected for any signs of settlement or leakage. Any defects identified by this inspection shall be corrected prior to final acceptance of the project.

APPENDIX ITEM 1

PLAN REQUIREMENTS CHECK LIST

GENERAL REQUIREMENTS

1. Correct sheet size (24" x 36").
2. Vicinity Map.
3. Location Map.
4. Index to drawings.
5. List of quantities.
6. List of agencies, including surveyor, soils engineer and all involved agencies for the project.
7. General, water and sanitary sewer notes. (Refer to Appendix Item 3.)
8. Professional Engineer, State of Colorado, seal and signature on every sheet.
9. North arrow on vicinity map, location map and each plan view .
10. Title block on each sheet.
11. Bench mark, including U.S.G.S. datum , location, elevation and monument type.
12. Street alignment, existing and proposed, shown on overall plan.
13. Street names.
14. Horizontal curve data for street centerline and all curbs shown on plan, or recorded plat included in plan set.
15. Street grades, existing and proposed shown on profile.
16. Typical street cross-section(s).
17. Street addresses for all lots and/or buildings indicated on plan, or address plat included in plan set.
18. Lot and block numbers.
19. Front lot dimensions.
20. Property, easement and tract lines shown on plan.
21. Private improvements identified.
22. Existing improvements identified.
23. Match lines and sheet references called out in plan and profile.
24. Street cross-pans shown.
25. Center line of drainage channel(s) shown.
26. 100-year flood plain limits shown.
27. Estimated construction cost and proposed development build-out schedule submitted.
28. Recorded plat and address plat submitted.
29. Project in conformance with overall water and sanitary sewer master plan.

SANITARY SEWER REQUIREMENTS

A. General

1. Sewer line horizontal alignment generally 6' south and west of street centerline; 5' min. from flow line; 10' min. from R.O.W. line.
2. All sewer lines shown in both plan and profile.
3. Manning formula hydraulic data including Q, V, D, d/D, S and n, indicated at connection(s) to existing system. Number and type of units and per unit average and peak flow s.
4. Sewer easement drawings and legal descriptions submitted with Professional Land Surveyor, State of Colorado, seal and signature affixed.
5. Sanitary sewer system notes included (refer to attached).
6. Sanitary sewer system details included.
7. Service wye locations, including size, manhole reach, lot or building number, stationing from nearest downstream manhole, right of left side connection looking upstream and the invert of the main at wyes and plugs shown in tabular form on the plans.
8. Note on plans: "No connections to existing system shall be made until the new lines have been tested and accepted by the District".

B. Sewer Plan View

1. Scale: 1" = 50'
2. Pipe size and material called out.
3. Bearings and linear footage between manholes called out along sewer reach.
4. Outside angles between sewer reaches called out at manholes. (deflection angle)
5. Sewer lines dimensioned from street centerline or property line, and from other utilities, curb and gutter and other obstructions.
6. Connection(s) to existing system shown on plan and tied to property corner or section corner.
7. Manholes properly numbered on plan.
8. Directional flow arrows shown.
9. Service line connections shown (service lines within easements not allowed).
10. At least a 10' workable easement margin on each side of the sewer line.
11. Manhole markers included for sewer line outside of paved R.O.W.
12. Match lines and sheet references.
13. All utility improvements, including water lines and storm sewer, shown on plans.

C. Sewer Profile View

1. Scales: 1" = 50' (horizontal)
1" = 5' (vertical)
2. Manholes properly numbered and stationed.
3. Pipe size, linear footage and grade called out between manholes.
4. Sewer line grades checked.
5. 1% minimum slope on dead-end mains.
6. Invert elevations for all entering and exiting pipes, rim elevations, cuts and drop inverts called out at the manholes.
7. Sewer service table showing lot number, station from downstream manhole, invert of sewer main at service and left or right side service included.
8. Inside manhole drop between inverts of highest entering pipe and lowest existing pipe not to exceed 1-1/2".
9. Connections to existing system shown on profile.
10. Crossings with other utilities shown on profile (1-1/2' minimum edge-to-edge separation)
11. Match lines and sheet references.

PINERY WATER AND WASTEWATER DISTRICT

Notes for Water and Sanitary Sewer System Plans

General Notes

- 1) These notes are intended for general information only. The Owner, Engineer & Contractor are advised to refer to the Pinery Water & Wastewater District technical specifications for specific requirements.
- 2) All water and sanitary sewer system plans and construction shall conform with the current Pinery Water and Wastewater District ("District") Specifications, and shall be subject to construction observation by District personnel or representatives. Copies of the District's Specifications may be obtained from the District.
- 3) The Owner, his Engineer or Contractor, shall schedule a pre-construction meeting with the District at least 48 hours prior to the start of construction. Construction plans, reviewed, signed and stamped by the District Manager and/or District Engineer, will be distributed at the pre-construction meeting. No construction will be permitted until all easements are signed and recorded and the pre-construction meeting has been held.
- 4) It is understood and agreed that a review of these plans and specifications by or on behalf of the Pinery Water And Wastewater District (PWWD) is only for determining general conformance to District Regulations and in no way implies any liability for materials used or the end product of the work contemplated herein. The District assumes no liability for the engineering design, information indicated on the drawings, geologic conditions, subsoil conditions, presence of groundwater and other conditions which might affect the construction, construction costs, operation and future maintenance of the project.
- 5) The Contractor shall be responsible for location and protection of all utilities encountered or anticipated during construction, whether shown on these plans or not. Contractor shall contact the respective utility companies and have all utilities field located prior to construction. Any utilities and/or structures damaged must be repaired or replaced by the Contractor prior to acceptance.
- 6) The Contractor shall obtain all required permits at his own expense and conform to notification requirements of the review agencies.
- 7) Where work is to be performed within easements, the Contractor shall take all necessary precautions to contain his work within the easement so far as possible. If necessary to extend construction operations beyond easement boundaries, the Contractor shall make all necessary arrangements with the Property Owner for such work. A copy of any easement will be furnished to the contractor upon request. Upon completion of construction, ground surfaces, fencing and other structures damaged or disturbed shall be replaced to the property Owner's satisfaction.
- 8) No trenches shall be backfilled until approved by the District Inspector except in emergency. Trenches shall be re-excavated and the pipe exposed for inspection at any location if so ordered by the Inspector.

- 9) The District, District Engineer and/or his Representative are not guarantors of the Contractor's obligations or his performance. Observations of work in progress and on-site visits are not to be construed as a guarantee by the District or its Representative of the Contractors' performance.
- 10) Backfill material within rights-of-ways or other traveled areas shall be compacted to 95% standard proctor density. Copies of all compaction tests for areas outside county rights-of-ways must be furnished to the District as the work proceeds.
- 11) "As-constructed" drawings supplied to the Owner's Engineer by the Contractor shall be checked by the Owner's Engineer and forwarded to the District for verifying the information with the records maintained by the District's Inspector. Upon District verification the Owner's Engineer shall prepare mylar "as constructed" drawings for the District records and one blue-line set along with an auto-cad disk of the plans as required by the District.
- 12) The District and/or its Representative is not responsible for safety in, on, or about the Project site, nor for compliance by the appropriate party of any regulations relating thereto.
- 13) Probationary acceptance of the new water and sanitary sewer systems will not be considered until all requirements are met. Requirements are detailed in the "Developer Service Agreement" filed at the District office.

Sanitary Sewer System Notes

- 1) The pipe used for sanitary sewer mains installed at depths of less than 22 feet shall be in accordance with ASTM D-3034 SDR 35 PVC pipe. Pipe installed at depths of 22 feet or greater shall be ASTM D-3034 SDR 26 PVC pipe. AWWA C900, Class 150 or AWWA C905, Class 150 shall be used where the sewer line needs concrete encasement or where 18" minimum vertical separation or 10 feet horizontal separation between water & sewer lines is not maintained.
- 2) Connection to existing District lines will be permitted upon acceptance of the new sanitary sewer system. Existing pipe at the point of connection shall not be "broken out" and no service connections will be made until the new system is accepted.
- 3) The sanitary sewer system shall be tested in accordance with Section 400 of the District Standards and Specifications. District testing requirements are extensive. The Contractor shall review testing requirements. All manholes in unpaved easement areas shall be tested with final grade rings & cover in place.
- 4) Probationary acceptance of the new sanitary sewer mains is contingent upon satisfactory completion of:
 - A. Low Pressure Air Testing
 - B. Manhole Vacuum Testing
 - C. Video Inspection
 - D. Final Manhole Inspection
- 5) All new mains must be jetted prior to probation. Additional jetting may be required prior to final conveyance and acceptance by the District. Costs of jetting will be the responsibility

of the Contractor. The Contractor will be responsible for all pumping associated with the line jetting.

- 6) The Contractor shall verify existing manhole inverts at proposed points of connection, prior to construction staking.
- 7) All sanitary sewer manholes shall be 4-foot (4') inside diameter with eccentric cones. All manholes shall be constructed in accordance with the Pinery Water and Wastewater District specifications.
- 8) The edge of manhole covers shall not be closer than 4-feet to the gutter pan.
- 9) Manhole rims shall be set 1/8-inch to 1/4-inch below finished street grade. See detail sheets for adjustment ring information in paved and unpaved areas.
- 10) In unpaved areas, manhole rims shall be set six (6") inches above finished grade. Manhole covers in unpaved areas shall be aluminum with cam locks.
- 11) Final grade adjustment of manhole covers and frame assemblies shall be completed utilizing high density polyethylene adjustment rings as manufactured by Ladtech, Inc. or approved equal. Adjustments for matching road grade shall be made using a molded indexed slope ring. Annular spaces shall be sealed with butyl sealant.
- 12) The Contractor shall take care to properly shape all manhole inverts and benches in accordance with District Specifications. Inverts of lines intersecting at 90 degrees and at highly divergent or flat slopes are especially critical. Manhole inverts shall be constructed with a smooth trowel or stone finish, and benches finished with a light broom, non-skid finish.
- 13) Exterior of manhole structures shall be coated with a waterproof bituminous membrane, or equal. The membrane shall be applied after the joints are grouted. Factory pre-coated manholes are acceptable if joints are taped per District specifications. The Contractor shall submit material specifications for the exterior coating to the District for review prior to construction. The exterior coating shall be applied per manufacturer's recommendations.
- 14) Sewer services shall be stubbed out at minimum 2% slope fifteen feet (15') within the property line. The end of the sewer service stub shall be marked with #4 rebar extending from the end of the service cap to 4 to 6 feet above the final grade.

or

Sewer services shall be stubbed out at minimum 2% slope fifteen feet (15') within the property line. The end of the sewer service stub shall be marked with 3M disks & 2'x4' post extending from the end of the service cap to 4 to 6 feet above the final grade.

- 15) All sewer service line locations shall have a "X" (for sewer) chiseled in the curb where curbs are present.
- 16) Service connections to the same main must be separated by at least 18 inches and be 18 inches or more from the end of the pipe section.
- 17) Manhole location markers shall be located and labeled per District instructions.

18) The estimated cost of construction is _____

Water System Notes

- 1) The pipe for water mains 14" and less in diameter shall be in accordance with AWWA C900 Class 150 PVC unless otherwise specified by the District. All 16" water mains or larger shall be in accordance with AWWA C905, DR 18 PVC. All water lines shall have a minimum of four and a half (4.5) feet of cover and be located a minimum of ten feet (10') from any sanitary sewer line.
- 2) All mechanical joint fittings require a joint restraint mechanism and bell restraints as specified.
- 3) Water main valves shall open counter-clockwise (left).
- 4) Air release/air vacuum valves (combination valves) shall be provided at all high points for water transmission lines without nearby service connections.
- 5) Water services shall be stubbed out ten feet (10') beyond the property line. All water service line locations shall have a "V" (for valve) chiseled in the curb where curbs are present. The meter cover shall be witnessed by a 6-foot metal fence post buried to expose three feet (3'). The post shall be set one foot (1') from the edge of the meter pit on the property side of the meter pit.
- 6) The meter cover shall be pre-drilled with a one and three-quarter inch (1 3/4") hole offset from the center of the meter cover for acceptance of a touch-read disk. A sample of a cover is available at the District.
- 7) All meter pits shall be staked for finish grade if installation precedes construction of adjacent curb or sidewalk. Meter pits shall be set to final grade by the Contractor. Meters will not be set unless pit covers are at acceptable grade.
- 8) The Contractor is responsible for notifying the local Fire Department and all customers affected by water outages during construction. All outages require prior approval by the District. The District shall operate all isolation valves required for the outage.
- 9) Water mains shall be deflected no greater than the Manufacturer's specification, or no greater than four degrees per joint, whichever is more stringent. All deflected water lines shall have high deflection couplings.
- 10) Water line location markers shall be located and labeled per District Instructions.
- 11) The estimated cost of construction is _____