SANITARY SEWER DESIGN CRITERIA AND POLICIES FOR CITY OF PUEBLO, COLORADO

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CITY OF PUEBLO, COLORADO

SANITARY SEWER DESIGN CRITERIA AND POLICIES

SANITARY SEWER DESIGN CRITERIA AND POLICIES MANUAL FOR THE CITY OF PUEBLO

CHAPTER 1. GENERAL PROVISIONS

1.1 JURISDICTION

All of the policies and design criteria set forth in this manual are adopted pursuant to the authority of Sections 4-2-2(i), 12-4-2(7), 12-4-5, 12-4-6(b)(3)(b) of the Pueblo Municipal Code, as amended, and shall apply to all land within the incorporated areas of the City, and all facilities constructed on City right-of-way (ROW), easements dedicated for public use, and to all privately owned and maintained sanitary sewer facilities.

1.2 PURPOSE AND INTENT

These regulations are adopted for the purposes of assuring safe, efficient operation of the wastewater system and are intended to prevent wastewater discharges to the system in concentrations or quantities which have the potential to harm or adversely affect the wastewater system, wastewater treatment process or equipment, or any receiving water. These regulations are adopted generally for the purpose of promoting public health and safety and preventing the occurrence of nuisance conditions. These regulations are not intended, nor should they be construed, to create any new rights, remedies, or benefits for any person, firm, corporation or entity.

All Master Development Plans, Subdivisions, Resubdivisions, Planned Unit Developments, Special Area Plans, or other proposed construction submitted for approval under the provisions of Title 12, Chapter 4 of the Pueblo Municipal Code shall include provisions for connection of such development to the City's sanitary sewer system, provisions to ensure adequate sewerage collection, and also, shall comply with the sanitary sewer design criteria and policies set forth in this manual. All designs, analyses, and reports shall be prepared under the supervision of a Professional Engineer (Engineer), licensed as such in the State of Colorado.

1.3 DEFINITIONS

"Backbone System" means that system of major wastewater collection interceptor sewer mains, typically including those greater than 12 inches in diameter (unless otherwise identified by the City), in addition to the wastewater treatment facilities.

"Backup" means the flow of sewage from a sanitary sewer owned and operated by the City into a private residence or business by means of the building sewer or service line, resulting from a blockage in the sanitary sewer owned by the City.

"Branch Sewer" means a sewer that receives wastewater from a relatively small area and discharges into a trunk sewer serving more than one branch-sewer area. Branch sewers are typically eight (8) inches to ten (10) inches in diameter. In plumbing, a branch sewer is the sewer to which an individual building sewer is connected.

"Building Drain" means that part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning two (2) feet outside the building wall.

"Building Sewer" or "Service Line" means that part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of the building drain and conveys it to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

"Campus" means a physically contiguous association of locations such as school or university buildings, several adjacent office buildings, warehouse buildings, manufacturing facilities, retail or wholesale stores, or a combination of buildings and open space under common ownership and/or management of a corporation, association, or group.

"CIRSA" means the Colorado Intergovernmental Risk Sharing Agency in which the City of Pueblo participates with other municipal governments within Colorado for certain risk management services.

"Collector Sewer" means a sewer located in the public way which collects the wastewater discharged through building sewers and conducts such flows into larger interceptor sewers and pumping and treatment works.

"Concrete Arch" is a bedding method as follows: The pipe is embedded in a compacted granular material having a minimum thickness of ¼ the outside diameter or 4 inches minimum between barrel and bottom of trench excavation and extending half way up the sides of the pipe. The top half of the pipe is covered with reinforced concrete arch having a minimum thickness of ¼ of the outside diameter or 4 inches minimum measured at the crown of the pipe and having a minimum width equal to the outside pipe diameter plus 8 inches.

"Cost Recovery" means the system established in Title 16, Chapter 5 of the Municipal Code that provides a mechanism for developers to partially recover the costs of installing excess capacity in sanitary sewer construction where oversize, off-site, or perimeter sewer improvements are required to ensure that construction of the sanitary sewer system proceeds in a planned and organized fashion and provides facilities that are adequately sized to serve reasonably anticipated future development.

"Depth of Sewer" means the vertical distance from the ground surface over the sewer to the top of the sewer pipe.

"Developer" means an owner or owners of one or more parcels of property intending to undertake a development of same.

"Development" means the entire development within the Property Master Plan (PMP). Individual subdivisions within the PMP are considered phasing of the development. Development means any one (1) or more of the following activities:

a. Subdivision or resubdivision of one (1) or more parcels of property into distinct or revised lots or parcels, or any other activity defined as a subdivision in Section 12-4-3 of this Code;

b. Procurement of any building or plumbing permit to construct improvements upon property which are intended for a use or occupancy likely to generate an increased volume of wastewater or produce wastewater with an increase in concentration of suspended solids, biological oxygen demand, metals or other pollutants; or

c. A rezoning of property which would permit a higher density use or other new use which would foreseeably generate an increased volume of wastewater over the use or uses of the property permitted by the existing zoning classification.

"Director of Public Works" is the manager of the Bureau of Public Works, or a designated representative.

"Hydrocleaning" means the process of cleaning sanitary sewer lines using high-pressure water jets that dislodges accumulated materials via the mechanical action of the water spray.

"Infiltration" is groundwater flow entering the sewer system, seeping in through defective pipe joints and cracks in manholes and sewer pipe. Infiltration does not include, and is distinguished from, inflow.

"Inflow" is flow entering the sewer system in the form of direct connections such as roof and area drains. Inflow does not include, and is distinguished from, infiltration.

"Intercepting Sewer" means a sewer that receives flow from a number of collector sewers or outlets and conducts such waters to the outfall sewer for treatment or disposal.

"Inverted siphon" is a depressed sewer that drops below the hydraulic gradient to avoid an obstruction such as a stream or drainage way.

"I&I" means any combination of infiltration and inflow, without regard to the source(s).

"Line" means a pipeline constructed for the purpose of conveying wastewater to the outfall sewer.

"Line size" means the interior diameter of a round pipe.

"Low tap" means a service line not constructed in accordance with the requirements of Sheet SD 21, Sanitary Sewer Trench Detail, of the Standard Construction Specifications and Standard

Details for the City of Pueblo, Colorado, in that it connects to the sanitary sewer line so that the flow line of the service line is below the spring line of the public sewer pipe for 8-inch and 10-inch sewer mains, or below the top one-quarter of the public sewer pipe for 12-inch and larger sewer mains.

"Master Development Plan" means a plan prepared in accordance with the requirements of Section 12-4-6(a) of the Pueblo Municipal Code.

"Non uniform flow" means a flow regime where the water surface varies non-uniformly over a horizontal distance due to a change in pipe size or grade.

"Off-site sewer collection system improvements" means sewer collection system improvements required to be constructed outside the boundaries of the property which is the subject of the development, and which, in addition to serving all foreseeable needs of the property which is the subject of the development, is also specifically intended and designed to be capable of providing sewer service to property other than the subject of the development.

"Outfall Sewer" means a sewer that receives wastewater from a collection systems or from a treatment plant and carries it to a point of final discharge.

"Peak flow" is the peak hourly flow.

"PMP" means a Property Master Plan which consists of Land Use Plan, Drainage Plan, Sanitary Sewer Master Plan, and Transportation Plan as required by City of Pueblo Annexation Agreement for the development.

"Private sewer" means a sanitary sewer main, pipe, or piece of equipment in a right-of-way or easement to which title has not been conveyed to the City of Pueblo, but which connects to the sanitary sewer collection system owned and operated by the City of Pueblo for the purpose of conveying sanitary sewage to Pueblo's water reclamation facility for treatment and disposition. A private sewer receives the discharge from one or more building drains and conveys it to a public sewer, private sewage disposal system, or other point of disposal.

"Protruding tap" means a service line not constructed in accordance with the requirements of Section 12.3.15 of the Standard Construction Specifications and Standard Details for the City of Pueblo, Colorado, in that it protrudes into a sanitary sewer line in such a manner that it can block the passage of cleaning equipment and can cause a blockage in the sewer line by providing a point at materials carried in sewage can accumulate to block normal sewage flow.

"Public or Public Use" means all buildings or structures that are not defined as private or private use.

"Public Sewer" means a common sewer directly controlled by the City of Pueblo.

"Pueblo Municipal Code" means Charter and Code of the City of Pueblo, Colorado.

"Relief Sewer" means (a) a sewer built to carry the flows in excess of the capacity of an existing sewer, (b) a sewer intended to carry a portion of the flow from a district in which the existing sewers are of insufficient capacity, and thus prevent overtaxing the latter, or (c) replacement of the existing sewer in place with a larger sewer main.

"Reimbursement" means payments made to persons to partially compensate for the costs of removing sewage and cleaning fouled structures in private homes or businesses resulting from a blockage in a sanitary sewer owned by the City.

"Sanitary Sewer" means a sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with minor quantities of storm, surface, and groundwaters that are not admitted intentionally.

"Sanitary Sewer System" means the collective public sewer system and treatment facilities.

"Service Line" or "Building Sewer" means that part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of the building drain and conveys it to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

"Service Stub" means a portion of a future building sewer running from the sewer main to approximately the property line.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"Sewer Main" or "Collection Line" means any portion of the wastewater treatment system which collects and transmits wastewater from the outfall of building sewers to the wastewater treatment plant, excluding service lines.

"Shallow Sanitary Sewer Service" means any sewer service too shallow to accommodate a basement by means of gravity flow.

"Springline" means the horizontal mid-height line of a pipe with a circular cross section, or a horizontal line at half the height of the minor axis for a pipe with a non-linear cross section.

"Standard Construction Specifications and Standard Details for the City of Pueblo, Colorado" means the manual developed by the City of Pueblo's Bureau of Public Works related to construction specifications and standard details, dated March 28, 2005, and as same may be amended.

"Trunk Sewer" means the principal sewer to which branch sewers are tributary. Trunk sewers are typically ten (10) inches to twelve (12) inches in diameter.

"UPC" means the that edition of the Uniform Plumbing Code produced by the International Association of Plumbing and Mechanical Officials specified in Title IV, Chapter 4, Article 1 of the Municipal Code, and as same may hereafter be amended.

"Wastewater" means the spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried waste from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and any lawfully or unlawfully contributed stormwater that may be present. Formerly referred to as sewage.

1.4 MODIFICATIONS

To the extent applicable, requests for modifications to the design standards and criteria set forth herein shall be submitted in accordance with Section 12-4-10 of the Pueblo Municipal Code, or as same may be amended.

1.5 RELATIONSHIP TO OTHER STANDARDS

Included in this manual are approved design methods, charts and tables, which when used will enable the City to perform its review in a more efficient and expeditious manner. If the Developer and/or land owner prefers to use other methods, charts or tables, prior approval shall be obtained from the Director of Public Works before submittal.

1.6 PERMITS AND OTHER REQUIREMENTS

The Developer and/or land owner shall be required to obtain all permits required by Federal, State, or Local Agencies in conjunction with work covered under this manual, and shall be required to comply with requirements which may be imposed directly by such agencies or which may be indirectly necessitated in order for the City to comply with any permit which may be issued to the City.

1.7 LIABILITY

The adoption of this manual shall not create any duty to any person, firm, corporation, or other entity with regard to the application, enforcement or nonenforcement of this manual. No person, firm, corporation, or other entity shall have a private right of action, claim or civil liability remedy against the City of Pueblo, or its officers, employees or agents, for any damage arising out of or in any way connected with the adoption, application, enforcement, or nonenforcement of this manual. Nothing in this manual shall be construed to create any liability under, or to waive any of the immunities, limitations on liability, or other provisions of, the Governmental Immunity Act, C.R.S. 24-10-101 et. seq., or to waive any immunities or limitations on liability otherwise available to the City of Pueblo or its officers, employees or agents.

Review and approval by the City of sanitary sewer improvements proposed in submittals does not relieve the engineer who designed such improvements from his professional responsibilities for the adequacy of the design of said improvements.

1.8 PRIVATE SEWERS AND PRIVATE PUMP STATIONS

All sanitary sewers constructed within the City of Pueblo, whether designed as private sewers or as public sewers, shall conform to all the design specifications set forth in this manual.

All sanitary sewers constructed within the City of Pueblo shall be considered public sewer mains unless specifically designated as private by the Pueblo City Council. This includes any sanitary sewer system that is extended beneath private roads, and sanitary sewers serving developments comprised of separate land parcels of record. Developers are required to provide adequate access to all sanitary sewer manholes regardless of their location in private roadways or parking lots.

Sanitary sewers underlying private property where all lots are under common ownership (i.e., shopping centers, business parks, campuses, golf courses, special area plans, condominium developments, subdivisions where the subdivision approval process includes special permission from the City Council for the sanitary sewer system within the subdivision to remain private, etc.) shall be considered private sanitary sewer service lines. Maintaining private sanitary sewer service lines shall be the sole responsibility of the property owner. The Pueblo Wastewater Department may respond in emergency situation (i.e., when a sanitary sewer overflow is in progress) to contain sewage spills and clear private mains. In such situations, the cost of emergency response shall be billed to the property owner at a rate of 150% of the actual cost of the response. In addition, the Wastewater Department will make telephonic reports of sanitary sewer overflows to the Colorado Department of Health and Environment (CDPHE). The Wastewater Department will advise CDPHE that the sanitary sewer overflow is the responsibility of the property owner, and will refer the name and address of the property owner to CDPHE for action.

Private sewers and pump stations are intended to serve only site specific developments, (i.e., shopping centers, business parks, campuses, golf courses, special area plans, condominium developments, subdivisions where the subdivision approval process includes special permission from the City Council for the sanitary sewer system within the subdivision to remain private, etc.) and shall not serve any area beyond the development or become part of the Sanitary Sewer System.

The City of Pueblo is not responsible for operating or maintaining private sewers or private pump stations.

CHAPTER 2. SANITARY SEWER PLANNING CRITERIA

2.1 GENERAL POLICIES

General policies and guidelines will be followed in order to develop a Sanitary Sewer System that will accommodate current and future needs of the City. The following addresses the major issues related to the development of the City's Sanitary Sewer System.

The purpose of the provisions contained herein are to provide sound engineering and long-range planning in the extension of the City's Sanitary Sewer System and promote the orderly development of the City's Sanitary Sewer System.

2.1.1 Development Policy

A. All Development within the City shall require connection to the City's Sanitary Sewer System.

B. Developer is responsible for the cost and construction of the Sanitary Sewer System required to serve the entire development in accordance with the Property Master Plan (PMP). The Sanitary Sewer System shall include, but is not limited to: manholes, sewer mains, service lines, pumping stations, force mains, and all necessary appurtenances.

C. The Sanitary Sewer System within the development is required to be sized to the ultimate capacity of that portion of the sub-basin area which will discharge through the development, and to include a reasonable portion of sub-basin area upstream of the development, as determined by the City based upon present and future development of property within the sub-basin area.

D. If a larger sanitary sewer system (including pumping systems) is required to serve a sub-basin area as described in 2.1.1.B and 2.1.1.C than is required to serve a particular development, the Developer will be responsible for installing the larger system. In such event, the Developer may be eligible to recover a portion of the larger system within the developed area.

Any cost recovery to the Developer for constructing a portion of the Sanitary Sewer System with a capacity greater than that required to serve the Development will be based on the following:

1. Cost recovery related to oversizing the collection system shall only be considered for sewer mains twelve (12) inches or larger. The dollar value eligible for cost recovery shall be the difference in the cost of pipe and installation between twelve (12) inches and the actual size installed.

2. Cost recovery related to oversizing pumping systems shall be based upon the difference in cost between the capacity required to serve the Development as described in 2.1.1.B and the capacity required to serve the sub-basin as described in 2.1.1.C, as determined from information and data submitted by the Developer and approved by the City of Pueblo.

E. Sanitary sewer lines smaller than twelve (12) inches are not part of the Backbone System. Proposed developments will not be allowed to connect to sanitary sewer lines smaller than twelve (12) inches unless adequate capacity is available to accommodate the proposed development. If capacity is available, connection to sanitary sewer lines smaller than twelve (12) inches may be approved by the Director of Public Works. If there is insufficient capacity in the existing sanitary sewer system, the Developer shall extend the sanitary system in accordance with Section 2.1.2. As an option, the Developer may upgrade existing sanitary sewer lines smaller than twelve (12) inches as approved by the Director of Public Works and consistent with the intent of the City's Master Sewer Plan.

F. Developments shall discharge to the Sanitary Sewer System(s) within the basin and at a point or points as identified in the City's Master Sewer Plan. In no case will proposed development(s) be allowed to discharge outside of its identified basin boundary unless otherwise approved by the City. However, Master Sewer Plans can be revised upon approval by the City.

2.1.2 Main Extension Policy

The main extension policy addresses the responsibility of extending the Sanitary Sewer System and allows for equitable cost recovery for said extensions.

A. The Developer shall be responsible for extending the Sanitary Sewer System from its connection to the Public Sewer to the exterior boundaries of the development including oversizing the sewer main extension, in accordance with the approved Sanitary Sewer Master Plan. If a Sanitary Sewer Master Plan has not been approved for the area, such extension shall be in accordance with the preliminary Sanitary Sewer Master Plan developed by the City.

B. The Sanitary Sewer System shall be sized to the ultimate capacity as described in Section 2.1.1.C and extended to the exterior boundaries of each subdivision within the development.

C. If the Developer has cause to extend the sanitary sewer main(s) or related facilities from outside the proposed development, (off-site sewer collection system improvements) the Developer is eligible for recovery of some of the costs for said off-site improvements and oversizing in accordance with Chapter 5, Title XVI of the Pueblo Municipal Code, or as same may be amended.

2.1.3 Relief Sewer Policy

If a proposed development cannot be served by the Backbone System (interceptors and outfalls) existing within the area, a new relief sewer shall be constructed in accordance with the approved Sanitary Sewer Master Plan. If a Sanitary Sewer Master Plan has not been approved for the area, such relief sewer shall be constructed in accordance with the preliminary Sanitary Sewer Master Plan developed by the City. It is the intention of the City to install or have installed, necessary and required relief sewers to mitigate impacts on the City's existing backbone Sanitary Sewer System, to the extent City funds therefore are made available by resolution of the City Council pursuant to Section 16-11-4 of the Pueblo Municipal Code, or as same may be amended.

2.1.4 Street or Alley Vacations

Streets or alleys that have active sanitary sewer mains in them will not be considered for vacation unless the sewer can be abandoned as a public sewer and it will not be used to serve future development or expansions upstream of the abandoned sewer. At such time a public right-of-way is vacated and a public sewer abandoned but continues to function as a private sewer main, provisions shall be made for the maintenance and repair of the private sewer (i.e. covenants and/or agreements).

2.2 DESIGN/PLANNING PERIOD

All improvements to the sanitary system shall be planned, designed, and constructed to provide adequate service for a useful life of 50 years unless a longer or shorter useful life period is stipulated or allowed by the Director of Public Works.

When allowed or stipulated by the Director of Public Works, construction of proposed improvements may be phased over a period of time (e.g., the pumping capacity of a lift station may be phased to match development rather than initially set at the future rate).

2.3 POPULATION AND LAND USE PROJECTIONS

All improvements to the Sanitary Sewer System shall be planned and designed to provide adequate service as specified by the following:

2.3.1. Planning Criteria for Sanitary Sewers

A. The area dedicated to each separate land use, calculated in acres, (such as single-family, multi-family, commercial, and industrial) shall be determined based upon the Master Development Plan.

B. Sanitary sewer impact shall be computed for the entire sewer drainage basin including the proposed development. Mains shall be designed to adequately accommodate the area as per criteria contained herein.

2.4 SANITARY SEWER FLOW COMPUTATION CRITERIA

2.4.1 Flow Factors

A summary of average and peak flow factors are summarized in the following table:

TABLE 2.1—SANITARY SEWER FLOW COMPUTATION CRITERIA FLOW FACTORS

Land Use	Average Flow "Per Acre" (1)		Peak Factor	Peak Flow "Per Acre" (1)	
	CFS	MGD		CFS	MGD
Single-Family Residential	0.0016	0.0010	2.6	0.0042	0.0027
Multiple-Family Residential	0.0003 per unit	0.0002 per unit	2.6	0.0009 per unit	0.0006 per unit
Commercial	0.0015	0.0010	2.6	0.0040	0.0026
Industrial	0.0020	0.0013	2.6	0.0051	0.0033
High-Water Consuming Industries	Special Study Required				
Institutional Use	Special Study Required				
Areas Outside The Development Plan(Unplanned)	0.0017	0.0011	2.6	0.0044	0.0028

(1) Unless otherwise stated

2.4.2 Infiltration and Inflow

Identify and design for areas with a high potential for groundwater infiltration. Maximum allowable infiltration/inflow (I/I) shall be in accordance with Article 12–Specifications for Sanitary Sewers. Use 0.0003 cfs per acre for newly developed basins with low potential for infiltration problems due to groundwater. Areas with high potential for groundwater infiltration shall be determined by the City or by studies done for the area.

2.5 WASTEWATER PUMPING STATIONS

Wastewater pumping stations will only be employed when gravity flow is not feasible; otherwise, pump stations will not be afforded planning consideration. The Engineer shall meet with the City prior to preparing the Engineering Report for a pumping station.

2.5.1 Engineering Report

If a pumping station is to be considered, a detailed engineering report shall be submitted to the Department of Public Works and shall include the following:

A. A brief description of the project and purpose.

B. A pumping station "feasibility study" which provides justification.

C. The engineering report shall elaborate on the following for both present and future conditions:

1. Design period
2. Population densities per acre and total population
3. Acres of area(s) served (including a map of the area(s) to be served)
4. Per capita wastewater contribution - average and maximum, (per Table 2.1)
5. Infiltration
6. Commercial and Industrial waste contributions
7. Design flow rates - average and maximum
8. Strength (BOD_5 and TSS) of wastewater and industrial waste characteristics

D. The report shall also address the following for both initial and future conditions:

1. Number, type, capacity, motor horsepower, phasing, voltage, and net positive suction head (NPSH) requirements of proposed pumping units.
2. System head curve (including head computations) for the pumping system
3. System head calculations shall include the size and length of force main and assumed C (Friction) factor.

4. Wastewater detention time in the wet well and force main.

CHAPTER 3. PROCEDURES/SUBMITTALS FOR SUBDIVISIONS AND MASTER DEVELOPMENT PLANS

3.1 SUBDIVISIONS

Procedures and submittals for subdivisions shall be in accordance with the Application, Review, and Approval Process Manual for Subdivisions, November 2002, and as same may hereafter be amended.

3.2 MASTER DEVELOPMENT PLANS

3.2.1 Sanitary Sewer Report

The Petitioner shall prepare a Sanitary Sewer Report in accordance with criteria as follows:

The gravity drainage basin or basins incorporating the proposed site and the service area boundary for the City's wastewater treatment plant shall be identified by a current elevation-topography information from the Pueblo County GIS Department in two (2) foot contour intervals.

The Report shall address the needs of the entire sewer drainage basin. This basin will be designated by the Director of Public Works. The Report shall discuss and analyze areas upstream of the site, within the gravity drainage basin, that would impact a trunk line or interceptor within the site. The existing wastewater system and the impact on that system by the proposed development shall also be addressed. The Sanitary Sewer Report shall provide a plan for anticipated improvements.

All sanitary sewer reports shall be typed on 8.5" x 11" paper and neatly bound in a folder which clearly identifies the development. A copy of the general location map and a master sanitary sewer plan shall be included in a folder pocket at the back of the report.

The Report shall be transmitted with a cover letter prepared by the Professional Engineer responsible for the preparation of the report, describing the project, noting any special conditions or problems encountered on the site, certifying that the sanitary sewer report was completed under his/her supervision in accordance with the City of Pueblo's sanitary sewer design criteria and policies, and that the design is in conformance with the City approved master plan for the basin, if one exists. The cover letter shall identify any modification to the criteria that may be requested. The final report shall be signed and stamped by the Professional Engineer responsible for the preparation of the report.

Two copies of the report are required upon submittal, one of which will be returned to the Engineer with comments or approval. If corrections or changes are required for approval by the City, two revised copies of the report, with all corrections or changes made, shall be submitted to the City for approval. Incomplete reports will not be accepted for review.

The Report shall include but not limited to:

1. Master Development Plan (Land Use Plan)

2. Tabulation of peak flows and preliminary pipe sizes.

3. Locations of all points on the City's existing sewer system where the new system will connect.

4. Identification of hydraulic deficiencies in the system caused by the Development (these deficiencies will have been identified by the City during an initial meeting with the Developer).

5. A discussion of any pumping stations, force mains, packaged treatment plants, and other special equipment as needed.

6. Any agreements that may be proposed.

3.2.2 Sanitary Sewer Report Criteria

The planning criteria presented in Chapter 2 and the design criteria presented in Chapter 4 will provide guidelines for the planning and design of sanitary sewers. In unusual circumstances or where special conditions dictate, certain deviations from the standard criteria may be directed or approved by the Director of Public Works.

CHAPTER 4. DESIGN CRITERIA

Design of both public and private sanitary sewers shall be in accordance with the following minimum design standards and specifications (Article 12–Specifications for Sanitary Sewers) of the City of Pueblo, Colorado:

4.1 DATUM

All vertical survey control for sewer design shall be based upon the most current North American vertical datum 88.

4.2 BENCH MARKS

Each sewer project shall have its own vertical control circuit, and each bench mark in the circuit shall be assigned the correct elevation in relation to all other bench marks in the circuit.

The closest bench mark to the proposed work shall be shown on each sewer profile sheet and on each sewer plan sheet on which elevations are shown.

4.3 DEPTH OF SEWERS

In general, sewers shall be designed deep enough to drain basements and to prevent freezing. No public mains shall be less than four (4) feet deep measured from the top of pipe unless special protection is provided, (i.e. reinforced concrete encasement, reinforced concrete arch, ductile iron pipe, etc.).

No building sewer/service line shall be less than four (4) feet deep in traffic areas without similar special protection listed above except that concrete driveways may be substituted for protection of service lines.

4.3.1 Service connections

In designing the minimum depth of public sewers, allowance must be made for the additional depth required to accommodate gravity flows from building sewers and to accept the rise of the service connection. Plat and construction plan notification, along with a separate notice/document (to be recorded) is required for shallow sanitary sewer service lines.

4.4 LOCATION AND ALIGNMENT

All public sanitary sewer mains shall be placed within the paved portion of the street when possible. Standard position for locating public sewers, unless some major interference prevents such location, is five (5) feet off of the street centerline and along the centerline of any sewer easement. The alignment in streets less than standard width shall be approved by the Director of Public Works. Whenever a sanitary sewer is placed within an easement, the sanitary sewer easement shall be a minimum of ten (10) feet wide on each side of the sewer main. If the sanitary sewer is to share an easement with another utility additional width may be required. If

the sewer is deeper than normal, 12 feet or greater to the top of pipe, a wider easement may be required. A wider easement may also be required due to unfavorable subsurface conditions (i.e. sand, groundwater, etc.).

Manholes shall be located so as to prevent entry of storm water. Proposed sewer lines which may conflict with the placement of other underground facilities will require prior approval of the sewer placement location by the controlling agencies whose facilities are affected. Locations other than those specified will also require specific approval of the Director of Public Works.

Installation of curvilinear sewer mains in sizes 8 inches through 15 inches in diameter are acceptable and may be necessary to obtain the standard location of sewer mains. Curvilinear sewers must be designed and constructed using a uniform slope between manholes and the curve of the pipe shall have a radius in accordance with the manufacturer's recommendations or the minimum radius of curvature indicated in the table below, whichever is greater. The necessary curvature shall be attained by deflection at joints not to exceed the applicable manufacturers' recommendations or by approved preformed joints or couplings. Sewer mains greater than 15 inches in diameter shall not be installed in a curvilinear alignment because they can be cleaned using a bucket machine, unless otherwise approved by the City.

TABLE 4.1—MINIMUM PIPE RADIUS

Pipe Diameter (inches)	Minimum Radius of Curvature (feet)
8	200
10	250
12	300
15	375

Changes in alignment for service lines shall be accomplished with preformed bends/fittings not to exceed 45°. When changes in direction exceed 45°, a two foot section of pipe shall be used to make the needed change of direction between fittings. Field bending of pipe shall not be permitted.

4.4.1 Relation to Water Mains

Where sewer lines cross water mains or come within ten (10) horizontal feet of each other, the sewer pipe shall be a minimum of 18 inches clear distance vertically below the water main. If this clear distance is not feasible, the pipe section must be designed and constructed so as to protect the water main. Minimum protection shall consist of the installation of an impervious and structural sewer. For example: at crossings,

a. One length of pipe at least 18 feet long centered over the water main. Joints between the sewer pipe and the special length pipe shall be encased in a concrete collar at least 6 inches either side of the joint;
b. Concrete encasement shall be at least 6 inches thick and extend a distance of ten (10) feet either side of the water main.

In all cases, suitable backfill or other structural protection shall be provided to preclude settling and/or failure of the higher pipe.

4.5 MULTIPLE PIPES IN A SINGLE TRENCH

Pipes shall not be installed one over the other in the same trench. Pipes adjacent to one another with little difference in invert elevation may be laid in the same trench provided the spacing between pipes is minimum of twelve (12) inches.

Pipes in close lateral proximity but at different elevations shall be installed as follows: the deeper pipe shall be installed with standard trench method then backfilled and compacted to an elevation at least one (1) foot higher than the top of the proposed higher pipe. The higher pipe shall be installed using standard trench method, backfilled and compacted to the level of the backfill of the first trench then final common backfill completed to the original or designed ground surface elevation.

4.6 PIPE MATERIALS

Acceptable pipe materials are referenced in the *Standard Construction Specifications and Standard Details for City of Pueblo, Colorado* under Article 12, Sanitary Sewers, Item 12.2 - Materials.

4.7 HYDRAULIC DESIGN

The size of pipe to be constructed as indicated on the plans will represent the inside or nominal diameter of the pipe or sewer. No public sewer shall be less than 8 inches in diameter. Privately owned branch sewers may be 6 inches in diameter, provided a six (6) inch will accommodate the entire development.

Pipe size requirements shall be computed by using Manning's formula. The Manning formula for circular pipes flowing full is:

$$Q = \frac{0.00061}{n} \; x \; d^{\frac{8}{3}} x \; s^{\frac{1}{2}}$$

or

$$Q = VA$$

or

$$Q = \frac{1.486}{n} R^{\frac{2}{3}} s^{\frac{1}{2}} A$$

Where Q = Flow in cubic feet per second
V = Velocity in feet per second
n = Friction factor
d = Pipe diameter in inches
D = Pipe diameter in feet
A = Area of pipe in square feet
s = Pipe slope in feet per foot.
R = Hydraulic radius = $\frac{area\ of\ pipe}{wetted\ perimeter\ of\ pipe} = \frac{D}{4}$ in feet

The following coefficients of roughness, "n" shall be used in Manning's formula for the computation of pipe capacity:

Table 4.2 - COEFFICIENTS OF ROUGHNESS

Type of Pipe	**"n"**
Vitrified Clay (VCP)	0.013
Polyvinyl Chloride (PVC)	0.010
Ductile Iron (polyethylene lined) (DIP)	0.010

Sewers shall be designed to flow at a maximum depth "d" of pipe inside diameter "D" at peak discharge per the table below. Peak flows will be determined by applying a 2.6 peak factor to the average design flow determined for the sewer.

Table 4.3 - DESIGN DEPTH OF FLOW	
PIPE SIZE	**DESIGN DEPTH OF FLOW (d/D)**
6" private	0.50
8"	0.50
10"	0.50
12"	0.67
15"	0.70
18" and above	0.75

In all cases, a depth-variable friction factor shall be used for the final design. See attached Figures 1 and 2 for depth-variable friction factors for circular pipes and PVC pipes. In these figures, the following terms apply:

Q_s = Flow at depth "d", pipe flowing partly full
Q_f = Flow with pipe flowing full
V_s = Velocity with flow at depth "d"
V_f = Velocity with pipe flowing full
d = Depth of water in pipe, measured vertically along centerline of pipe
D = Pipe diameter, full flow depth

Figures 1 and 2 shall be used to determine the allowable contributing flow to a new sewer based upon a known diameter and slope. For example, a new 10" PVC sewer is to be constructed. The sewer slope is 3 feet per 1000 ft. The allowable depth of flow is 0.5, thus d/D is 0.5. Using Figure 2, the hydraulic element Q_s/Q_f is 0.4 and V_s/V_f. is 0.8. Knowing that the Q_f is 1.56 cfs, then the allowable peak flow contribution by the Developer to this sewer is 0.62 cfs (1.56 cfs x 0.4). With V_f of 2.86 ft/s, the 0.5 depth of flow will have a velocity of 0.8 x 2.86 ft/sec or 2.29 ft/sec.

FINAL DESIGN

Size of Pipe: 10 (diameter in inches)
Type of Pipe: PVC
Manning's "n" value (Table 4.2): 0.010
Pipe Slope: 0.003 (feet per foot)

Calculate Q_f = 1.56 cfs
Calculate V_f = 2.86 fps
Design d/D (Table 4.3): 0.50

$\frac{Q_s}{Q_f}$ (Figure 1 or 2): 0.4

$\frac{V_s}{V_f}$ (Figure 1 or 2): 0.8

Allowable Peak Flow: $Q_s = (Q_f \times \frac{Q_s}{Q_f}) = (1.56 \times 0.4) = 0.62\ cfs$

Velocity at Flow Depth: $V_s = (V_f \times \frac{V_s}{V_f}) = (2.86 \times 0.8) = 2.29\ fps$

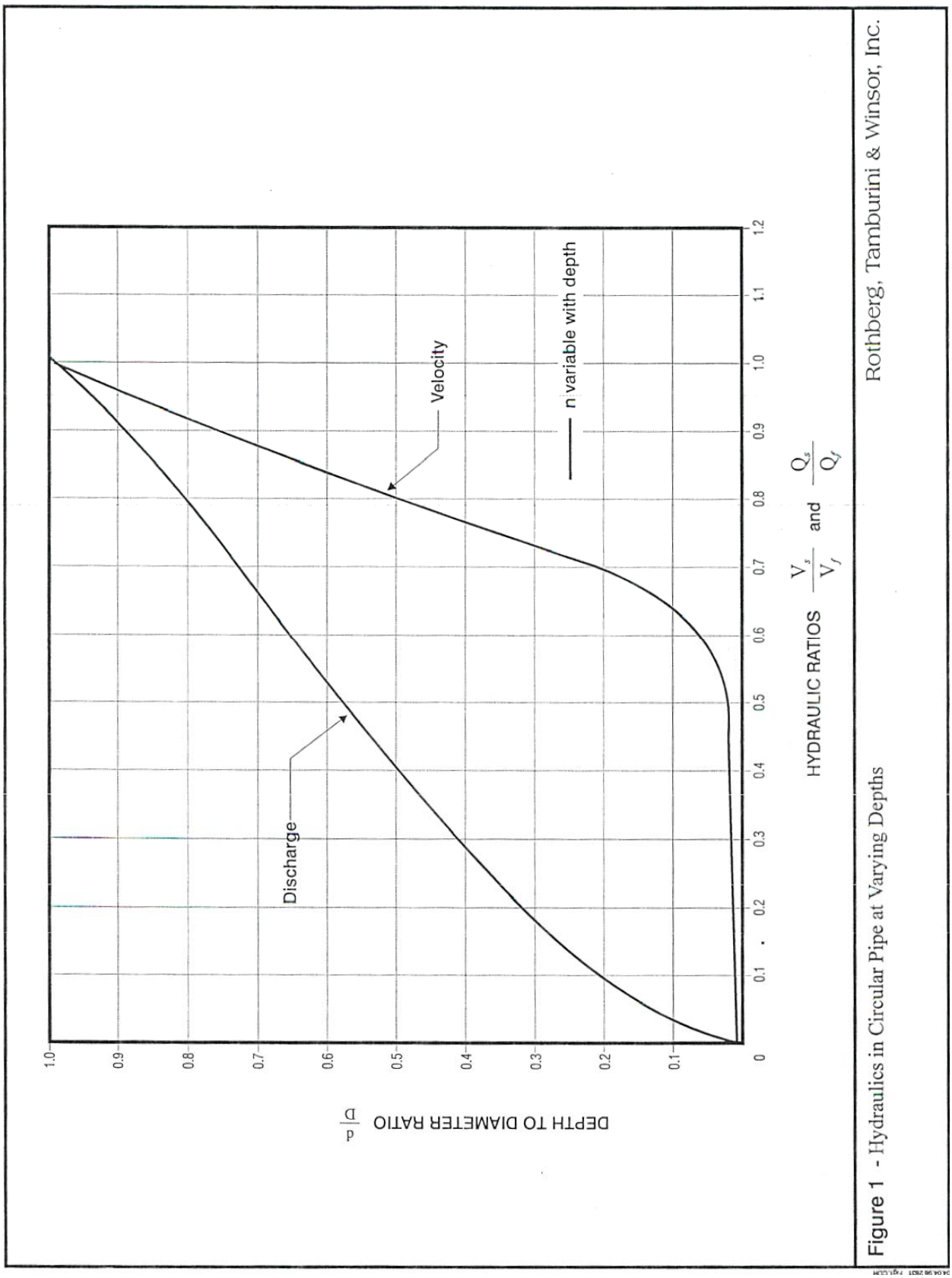


Figure 1 - Hydraulics in Circular Pipe at Varying Depths

Rothberg, Tamburini & Winsor, Inc.

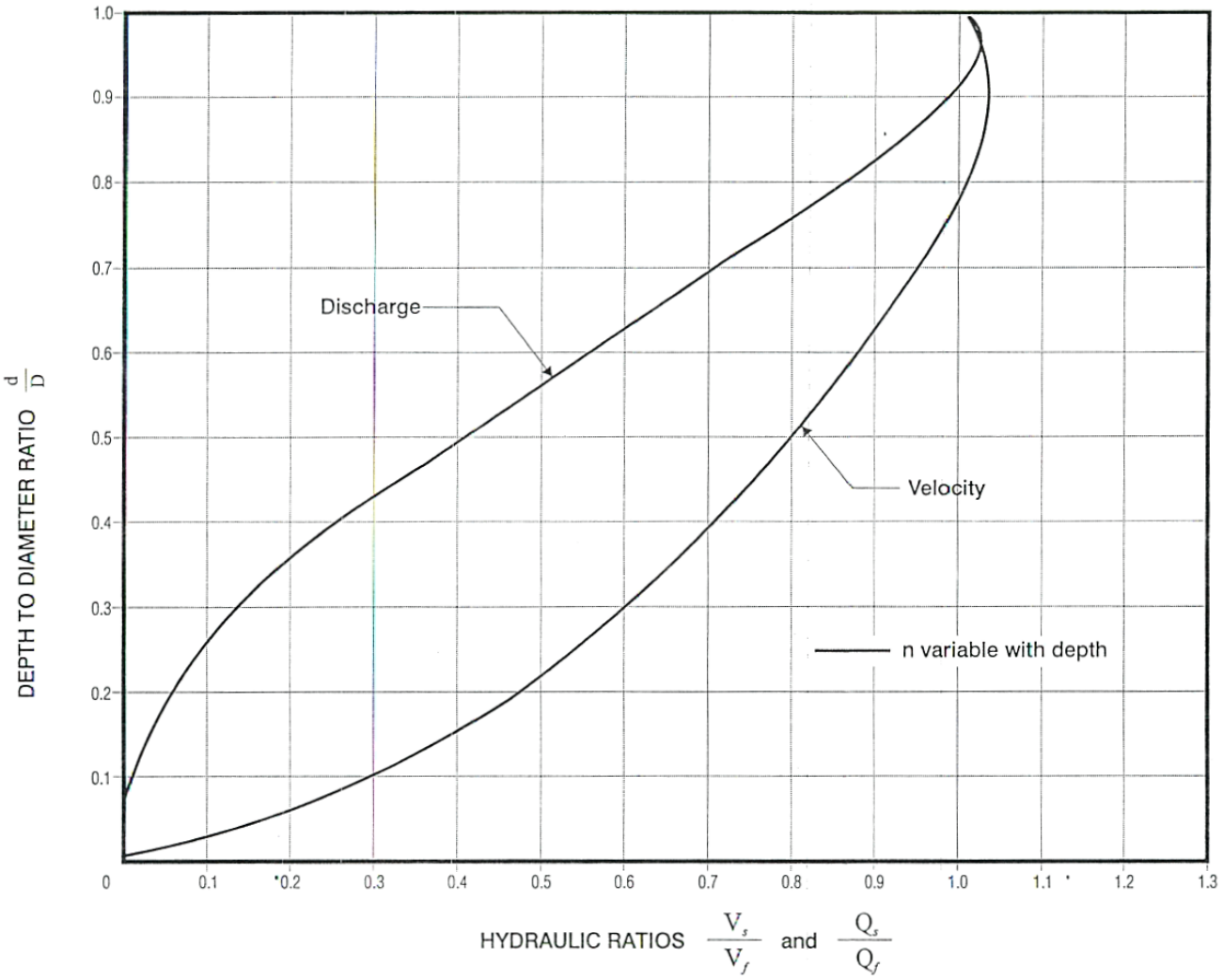


Figure 2 - Hydraulics in PVC Sewer Pipe at Varying Depths

Rothberg, Tamburini & Winsor, Inc.

4.7.1 Slope of Sewers

All sewers should be designed to transport average wastewater flows at mean velocities of two feet per second based on the appropriate roughness factor. The slope between manholes shall be uniform. The slope for sewer mains shall not be less than 0.40% unless the Engineer can demonstrate why a lesser grade is necessary and as approved by the City. The required minimum velocity shall be 2.0 feet per second (fps). The desired minimum velocity is 3.0 feet per second. The desired maximum velocity is 9.5 feet per second. Sewers designed to carry an average design flow of less than 0.1 cubic feet per second shall not be installed at a slope of less than 0.6 ft/100 feet.

4.7.2 Hydraulic Jumps

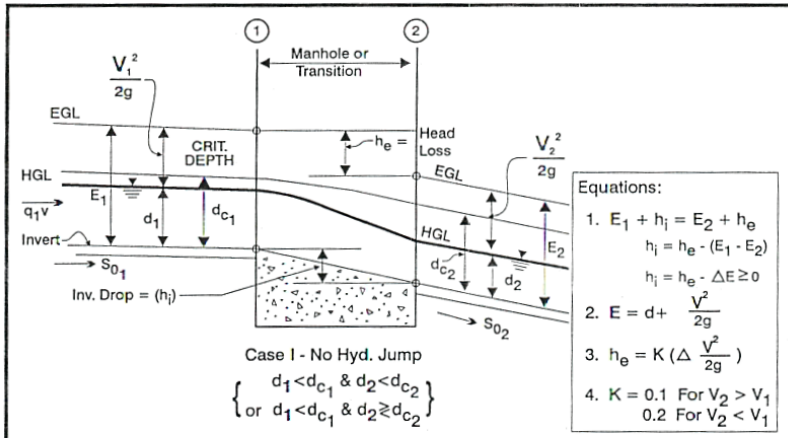
Hydraulic jumps may occur in manholes when the slope of the upstream pipe is greater than the downstream pipe. Care shall be exercised to avoid hydraulic jumps in conduits. When unavoidable, structures shall be designed per Figure 3 and submitted with calculations for approval.

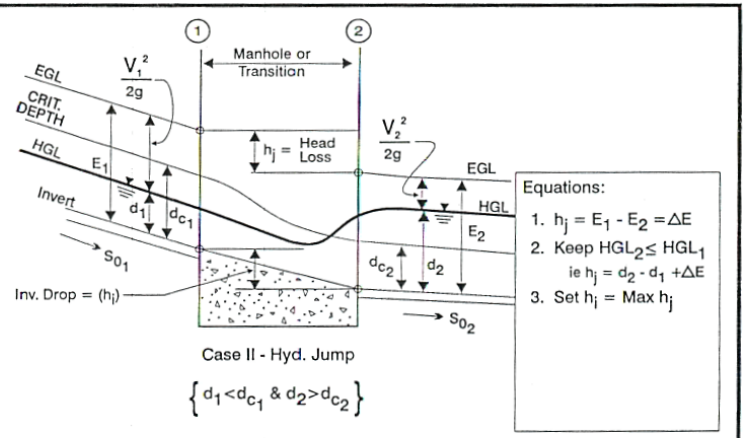
4.7.3 Steep Grades/High Velocities

In the case of sewers where the slopes are such that over 15 percent grades are used or the flow velocity exceeds 9.5 feet per second, special provisions shall be made to prevent displacement of pipes and manholes by erosion and hydraulic forces. Such protection (i.e. pipe anchors, special manholes, etc.) shall be shown on detail drawings and approved by the Director of Public Works.

4.8 MANHOLE, JUNCTION STRUCTURES, AND CLEANOUTS

Manholes shall be installed at the end of each line, at all pipeline intersections, changes in grade, size, alignment (except curvilinear sewers), and at distances not greater than those listed in Section 4.8.5 below. For curvilinear sewers, manholes must be placed at all intersections, changes in grade, changes in size, and at distances not greater than 400 feet. Manholes must also be provided at all points of reverse curve, or where required by the Director of Public Works. Manholes must be located to allow unassisted access by maintenance vehicles which range in size from ½ ton to 2 ½ tons. All manholes located outside of dedicated street or alley rights-of-way will be designed and constructed with a lock down type cover as approved by the Director of Public Works. Lines and manholes located in areas where access, in the opinion of the Director of Public Works, is not possible, will not be approved for construction.





M.H. #	Line Up Stream - PT (1)								Line Down Stream - PT (2)								Case I - No Hyd. Jump					Case II - Hyd. Jump			Remarks
	DIA D_1	q_1	S_{0_1}	d_{c_1}	d_1	V_1	$\frac{V_1^2}{2g}$	$E_1 = d_1 + \frac{V_1^2}{2g}$	DIA D_2	q_2	S_{0_2}	d_{c_2}	d_2	v_2	$\frac{V_2^2}{2g}$	$E_2 = d_2 + \frac{V_2^2}{2g}$	$\Delta E = (E_1 - E_2)$	$\Delta \frac{V^2}{2g}$	K	$h_e = K(\Delta \frac{V^2}{2g})$	$h_i = (he - \Delta E)$	$h_g = \Delta E = (E_1 - E_2)$	$h_j = \Delta d = (d_2 - d_1)$	$h_i = h_j$ (Max)	
	ft.	cfs	%	ft.	ft.	fps	ft.	ft.	ft.	cfs	%	ft.	ft.	fps	ft.	ft.	ft.	ft.		ft.	ft.	ft.	ft.	ft.	

Figure 3 - Manhole & Transition Loss Hydraulic Computations
(Page ___of___)
Calc. By._____ Date:_____

Rothberg, Tamburini & Winsor, Inc.

4.8.1 Manhole Rings and Covers

Manhole rings and covers shall conform with the detail sheets for ring and cover designs per the *Standard Construction Specifications and Standard Details for the City of Pueblo, Colorado*.

4.8.2 Flow Channel

The flow channel shall be made to conform in slope and shape to that of the sewer pipe and wherever possible, shall use the lower one-half of the sewer pipe for the invert of the open flow channel. At intersections with other lines, channels shall be formed with a sweeping curve to minimize turbulence.

4.8.3 Manhole Steps

Manhole steps shall be not less than eighteen inches nor more than twenty-four inches from the top of the manhole ring and not more than twenty-four inches from the bench of the manhole. Intermediate steps will be a sixteen inches apart, plus or minus ¾ inch. Steps shall be made of minimum ½ inch steel bar conforming to ASTM A615 Grade 60 encapsulated in copolymer polypropylene. The steps shall be capable of withstanding a force of 350 pounds, applied at any place on the step and in any direction which projects from the point of application through a diameter of the step cross section at that point, with no permanent deformation resulting.

4.8.4 Manhole Drops

A drop manhole will be required when the difference between the elevation of the inlet and outlet flow lines is two feet (2') or greater. The incorporation of outside drop manholes into a pipeline system should be restricted by the designer to those locations where no other means of attaining slope or accommodating adequate flow velocity is feasible or where there are physical limitations, (i.e., rock, groundwater, etc.). Outside drop manholes shall conform with standard detail in configuration and size. See the *Standard Construction Specifications and Standard Details for City of Pueblo, Colorado*.

4.8.5 Manhole Spacing

The maximum distance between manholes shall be as follows:

Pipe size	Maximum Distance
8" to 21"	400 feet
larger than 21"	500 feet
private sewers (when installed)	300 feet (per UPC)

4.8.6 Taps to Manholes

Sanitary service lines (building sewers) shall not be connected to the city main-line manholes unless otherwise approved by the Director of Public Works.

4.8.7 Intersections

All pipes shall have free discharge into the collection system. Where possible, the flow line of the intersecting pipe shall be at or above the design depth of flow of the collection sewer. Minimum elevation drops at manholes are as follows:

Horizontal Deflection Angle of Sewer Pipe at MH	Minimum Drop
0°	0.1 feet
Between 0° and 45°	0.2 feet
45° to 90°	0.3 feet

Changes in direction at intersections shall not be greater than 90°. The minimum drop at a manhole with a 0° pipe defection can be less than 0.1 feet when the grades of the pipe entering and exiting the manhole are the same and the pipe is laid continuous through the manhole, using the bottom half of the pipe as the channel.

4.8.8. Cleanouts

For private sewer mains, cleanouts may be installed in lieu of manholes. Cleanouts shall be installed in accordance with the provisions of the Uniform Plumbing Code.

4.9 PUMP STATIONS AND FORCE MAINS

Wastewater pumping stations are to be situated above flood levels by building a suitable structure, preferably located off the right-of-way of streets and alleys. Pump stations will be built for easy access into the pump-house. When wastewater must be pumped prior to grit removal, the wet well and the discharge piping shall be designed to prevent grit accumulation. It is the intent of the City that pump stations be standardized.

4.9.1 Configuration

The following items should be given consideration in the design of wastewater pumping stations:

Wet wells and dry wells, including their super-structure, should be completely separated.

Provisions should be made to facilitate removal of pumps, motors, and valves for replacement/repair.

Suitable and safe means of access should be provided to dry wells and to wet wells containing either bar screens or other mechanical equipment for inspection or maintenance. (Stairways are preferred)

4.9.2 Pump Equipment Characteristics

A. Duplicate Units

Multiple pump units must be provided. Should only two units be provided, equal capacity is required. Each pump shall be capable of handling flows in excess of the expected maximum flow. Where three or more pumps are provided, they should be designed to fit actual flow conditions and must be of such capacity that with any one pump out of service, the remaining pumps will have capacity to handle maximum wastewater flows.

Ejector - type and suction lift pumping stations will not be allowed unless approved by the Director of Public Works.

B. Protection Against Clogging

Pumps handling raw wastewater should be preceded by readily accessible screens with clear openings not exceeding 2 inches, unless special devices such as comminutors are installed to protect the pumps from clogging or damage.

If the size of the installation warrants, a mechanically cleaned bar screen with grinder is recommended. Where screens are located below ground, convenient facilities must be provided for handling screenings. For the larger or deeper stations, duplicate units of proper capacity are preferred.

1. Pump Openings
   Pumps should be capable of passing spheres of at least 3 inches in diameter. Pump suction and discharge openings shall be at least 4 inches in diameter.

2. Priming
   The pump should be so placed that under normal operating conditions, it will operate under a positive suction head. The NPSH and suction lift requirements of the pumps shall be considered.

C. Electrical Equipment

Electrical equipment, located in enclosed areas where gas may accumulate, shall comply with the National Board of Fire Underwriters' specifications for hazardous locations. Electrical equipment for pump motors shall contain elapsed time meters.

D. Intake

Each pump should have an individual intake. Wet-well design should be such as to avoid turbulence near the intake and cavitation in the pump.

E. Dry-well Dewatering

A separate sump pump shall be provided in dry wells to remove leakage or drainage with the discharge to the wet well above the overflow level of the wet well. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to point of drainage.

F. Pumping Rates

The pumps and controls of main pumping stations, and especially pumping stations operated as part of treatment works or in developing areas, should be selected to operate at varying delivery rates to permit discharging wastewater from the station to the treatment plant at approximately the rate of delivery to the pump station.

G. Pump Controls

Liquid level controller activators should be so located as not to be affected by flows entering the wet well or by the suction of the pumps. Float tubes in dry wells shall extend high enough to prevent overflow. Provisions should be made to provide automatic alternations of the pumps in use.

H. Pump Valves

Suitable (readily accessible) shutoff valves will be located on suction and discharge lines of each pump. A check valve or pump control valve shall be placed on each discharge line, between the shutoff valve and the pump.

I. Pump Wet Wells

1. Divided Wells
   When continuous pump station operation is required, division of the wet well into two sections may be constructed, with properly interconnected control gates, to facilitate repair and cleaning.

2. Size
   The effective capacity of the wet well should provide a holding period not to exceed 30 minutes for the design minimum flow. Smaller wet wells may be considered when utilizing variable capacity pumping systems.

3. Floor Slope

The wet well floor should have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom should be no greater than necessary for proper installation and function of the pump inlet.

J. Pump Station Ventilation

Adequate ventilation shall be provided for all pump stations to mechanically ventilate the dry well. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, it shall be mechanically ventilated. There shall be no inter-connection between the wet well and dry well ventilating systems. In pits over 15 feet deep, multiple inlet and outlets are desirable. Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions in the air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located conveniently. Consideration should be given to automatic controls where intermittent operation is practiced.

Where excessive moisture or low temperatures become a problem, consideration should be given to installation of heating and/or dehumidification equipment.

1. Wet Wells

If mechanical wet well ventilation is required it should be continuous and should provide at least 12 complete air changes per hour. For intermittent operation, at least 30 complete air changes per hour should be provided.

2. Dry Wells

Ventilation may be either continuous or intermittent. For continuous operation, at least 6 complete air changes per hour should be provided. For intermittent operation, at least 30 air changes per hour should be provided.

K. Flow Measurement

At larger pumping stations, installation of suitable devices for measuring, recording and totalizing wastewater flow and power consumption should be a design consideration.

L. Water Supply

There shall be no physical connection between any potable water supply and a wastewater pumping station; otherwise contamination of the potable water supply may result. Provision of a water supply for washdown should be planned.

M. Power Supply

Electric power supply will be tied-in from at least two independent generating sources, or emergency power equipment should be provided. Automatic starting of emergency power equipment shall be installed. Emergency power generation units or portable pumping equipment on standby are considerations.

An overflow should be provided at such an elevation as to prevent basement flooding or back water from affecting the operation. Where power failure would result in objectionable conditions because of resultant discharge or basement flooding, an emergency operation capability shall be provided. The need for the latter requirement will be determined for each proposed installation at the time plans are reviewed.

N. Alarm Systems

Alarm systems shall be provided for all pumping stations. The alarm shall be designed and installed so as to activate in cases of power failure, pump failure, or any other pump station malfunction. Pumping station alarms shall be telemetered. An audio-visual device may also be installed at the station so as to allow surveillance from the outside.

O. Instruction

Wastewater pumping stations shall come with a complete set of equipment operational and maintenance manuals. The manuals shall include emergency procedures, maintenance procedures, tools and such spare parts as may be considered necessary.

Operation and maintenance manuals shall also be provided for all emergency power generation equipment.

P. Force Mains

1. Size
   The minimum allowable force main size is four inches in diameter

2. Velocity
   At the design pumping rate (initial and ultimate), the velocity shall be at least three feet per second, but no more than five feet per second.

3. Air relief valves
   Automatic air relief valves shall be placed at high points in the force main to prevent air locking.

4. Termination
Force mains shall enter the gravity sewer system at a point not more than two feet above the flow line of the receiving manhole.

Q. Pump Cycling

Pump, wet well and force main configuration and capacity will be considered in order to reduce excessive pump cycling over the range of flow rates expected during the design life of the pumping station.

R. Special Conditions

Pumping station designs which do not follow the design criteria listed above will be evaluated on an individual basis. Special circumstances may warrant additional requirements.

4.10 INVERTED SIPHONS

The use of inverted siphons in sewer design shall be avoided, except in the most exceptional cases. Where proposed, justification must be presented.

Inverted siphons shall have at least two barrels, with a minimum pipe size of eight (8) inches, and shall be provided with necessary appurtenances for convenient flushing and maintenance; the inlet and outlet structures shall have adequate clearance for rodding; and, in general, sufficient head shall be provided and pipe sizes selected to insure velocities of at least 3.0 feet per second under both initial and future conditions. The inlet and outlet details shall be arranged so that the normal flow can be diverted to one barrel and so that either barrel may be removed from service for cleaning.

4.11 STUB-ENDS OF LINES

Future pipeline extension requirements should be addressed, including provision of manhole stub-outs at the end of a pipelines. However, stub-outs should not be used in cases where no future extension of the sewer is possible or contemplated. Taps to stubs shall not be allowed.

4.12 STREAM AND DRAINAGE CROSSINGS

All stream and drainage channel crossings greater than 35 feet in length shall be ductile iron encased in reinforced concrete unless otherwise approved by the City (see detail sheet in the *Standard Construction Specifications and Standard Details for City of Pueblo, Colorado*). For crossings less than 35 feet, either SDR 26 PVC or ductile iron can be used, encased in reinforced concrete.

Stream crossings less than four feet below existing or proposed channel bottoms shall be supported by reinforced concrete caissons, drilled a minimum of five feet into an impervious soil

unless deemed unnecessary by the City as determined on a case by-case basis. In the absence of impervious soils, caissons shall extend twenty feet below the invert of the sewer main.

4.13 RAILWAY AND HIGHWAY CROSSINGS

Design of crossings shall conform to the requirements of the Railroad Company or the Colorado Department of Transportation.

4.14 HYDROGEN SULFIDE PRODUCTION

Short and long term hydrogen sulfide production effects within any Sanitary Sewer System should be addressed by the designer particularly with respect to identifying and pinpointing those locations where high generation potential is likely. The effect of deterioration caused by hydrogen sulfide must be assessed in designing pipelines to ensure that a fifty (50) year operational life is provided by the design.

The following settings have the potential to generate high levels of hydrogen sulfide:

1. Areas of high-turbulence in the stream-flow which generate disagreeable and unacceptable levels of hydrogen sulfide gas.

2. Areas where sulfide levels equal or exceed 1 mg/liter and rates of flow are low without benefit of daily cleansing/oxidation velocities, or where detention creates a loss of free oxygen levels below 50% of normal.

3. In areas where stream temperatures rise above the normal within the sewer line environment due to highly thermal discharge points or sources.

Design approaches which will be required in avoiding or reduction of corrosive or malodorous gas and in providing for greater pipeline and manhole design life are:

1. Use of pipe material which does not react to acid attack (e.g. PVC).

2. For pipe sizes greater than 27", use a pipe material only as approved by Director of Public Works.

3. Treatment of flows with chlorine, lime, iron or zinc salts, hydrogen peroxide or nitrate chemical compounds in sufficient quantities to eliminate dissolved sulfide based upon a periodic maintenance schedule for the length of pipeline affected.

4. Providing a coating or sleeve inside the pipeline with a material which is non-reactive to hydrogen sulfide (beware of fabrication faults however, which may accentuate sulfide concentrative deterioration).

5. Epoxy lining of manholes or other structures constructed on backbone systems.

6. Increasing the size of pipe above the "otherwise appropriate design", even though the larger pipe is seemingly oversized for the design flow. This design measure is intended to increase the wastewater surface area leading to greater reservation and less sulfide generation. Also, the perimeter of the sewer (and thus "dry" surface area) increases with increasing pipe size leading to less wall penetration from a given amount of acid.

4.15 CONCRETE PROTECTION IN HIGH-SULFATE SOILS

High-sulfate soils are common throughout Pueblo. To protect concrete installations from corrosion in high-sulfate soils, all concrete mixes must comply with the specifications presented in Article 4 of the Standard Construction Specifications and Standard Details for the City of Pueblo, Colorado, February 26, 2001, and as same may be amended.

4.16 PROTECTING EXISTING SEWER SYSTEM DURING CONSTRUCTION

New sewer mains shall remain functionally disconnected from the existing sanitary sewer system during construction to prevent dirt and debris from entering the existing sewer system. Connection of new sanitary sewer mains to the existing sewer system shall be made at an existing manhole where feasible. Where a sanitary sewer main is connected to the existing system between existing manholes, a new manhole shall be constructed at the point of connection. The connection of all new sanitary sewer mains to the existing sanitary sewer system shall be accomplished in such a manner that all existing services are maintained, and that no refuse, concrete, asphalt or other extraneous matter enter the existing sewer.

The Wastewater Department shall install a debris trap in the sanitary sewer system at the connection manhole or at another appropriate location to prevent the introduction of construction debris, refuse, concrete, asphalt, or other extraneous matter into the sanitary sewer collection system. The debris trap shall be inserted prior to commencement of new sanitary sewer construction, or as soon thereafter as feasible. All inspections required for acceptance of a new sewer in Article 12 of the most recent version of the Standard Construction Specifications and Standard Details for the City of Pueblo, Colorado shall be completed, and the street overlying the new sanitary sewer shall be paved, prior to the new sanitary sewer being accepted by the City and placed in operation.

Following completion of paving, the new sanitary sewer shall be flushed and inspected again to ensure that is free from construction-related debris. The developer or contractor shall be required to clean the new sewer as needed to ensure that all construction-related debris is removed prior to removing the debris trap and allowing the new sanitary sewer to be placed in operation.

During construction it shall be the sole responsibility of the developer or contractor to ensure that any liquid and debris from the new sewer system is removed from any accumulation point or from the ground, and disposed of in a manner that complies with all federal, state and local environmental and community health regulations. The developer or contractor shall ensure that

water debris from the new sanitary sewer construction do not cause or contribute to a nuisance condition.

4.17 EPOXY COATING

The interior surface of the manholes on backbone systems will be lined with a 100% solid, self-priming, ultra-high build epoxy applied to a minimum thickness of 100 mils with an airless spray gun applicator. Protective lining shall completely cover all manhole bases including inverts. Epoxy coating shall conform to the following performance testing.

DESCRIPTION	METHOD	RESULTS
Flexural Strength	ASTM D790	13,000 psi
Compressive Strength	ASTM D695	18,000 psi
Tensile Strength	ASTM D638	7,600 psi
Tensile Ultimate Elongation	ASTM D638	1.5%
Hardness, Shore D	ASTM D2240	88
Water Vapor Transmission per 24 hrs	ASTM D1653, Method B	3.8gms/sp.m
Taber Abrasion, CS17 Wheel	ASTM D4060, 1000g load/1000 cycles	<112mg loss
Temperature Resistance	ASTM D4541, Concrete	200 deg F

CHAPTER 5. OPERATION AND MAINTENANCE OF SEWERS

Responsibility for the operation and maintenance of the Sanitary Sewer System is hereby defined.

5.1 PUBLIC SEWERS

Only after dedication by the Developer, construction of the improvements in accordance with the approved design, and written acceptance of the improvements by the City will the operation and maintenance of the public Sanitary Sewer System become the responsibility of the City. Maintenance by the City shall be conducted as part of the regular sewer maintenance program of the City. Such maintenance shall not extend to any building sewer or private sewer as defined herein.

5.2 PRIVATE SEWERS

Private sewers shall be the responsibility of the Owner(s) to install, maintain and repair. The provisions of the operation and maintenance of any private sewers shall be clearly defined in the Declaration of Covenants for each subdivision or development.

5.3 SANITARY SEWER BACKUPS

5.3.1 Responsibilities

5.3.1.1 Standard of Care

The City of Pueblo exercises what it believes to be a reasonable standard of care in maintaining and cleaning sanitary sewer lines by cleaning the City's lines at least once per 24 months using hydrocleaning. If a City sanitary sewer line has been hydrocleaned within 24 months prior to a backup event, the City is deemed to have exercised a reasonable standard of care, the City is not negligent, and negligence on the part of the City is deemed not to have been the proximate cause of the event.

5.3.1.2 Emergency Response

The City of Pueblo makes reasonable effort to provide emergency response to sanitary sewer problems, including backups, on a 24-hour basis. This response is provided by means of assigning employees to standby duty, with communication accomplished by means of mobile telephones.

5.3.1.3 Homeowner/Business Owner Responsibilities

Homeowners and business owners are responsible for maintaining building sewers, service lines, and private sewers that connect structures to sanitary sewers. Roots protruding from service lines and grease discharged from household taps are frequent causes of sanitary sewer backups.

Protruding taps can block the passage of cleaning and inspection equipment, thus preventing normal maintenance activities, and they can block the movement of materials through the sanitary sewer line resulting in backups. Low taps increase the likelihood of backups because they are constructed in a manner that allows wastewater to flow from the sanitary sewer line into a service line. Because they are part of the service line, protruding taps and low taps are the responsibility of the homeowner or business owner.

5.3.1.4 Roots and Grease

Roots protruding from service lines and grease discharged from household taps are frequent causes of sanitary sewer backups. The Municipal Code of the City of Pueblo prohibits the discharge to the sanitary sewer collection system of materials in such concentration or amount as to restrict the hydraulic capacity of the collection system (Section 16-7-14(3)). Where roots enter the sanitary sewer collection system from a private sewer or service line, removal of such roots are the responsibility of the homeowner or property owner, and the City cannot assume responsibility for backups caused by such conditions where normal maintenance activities have been performed within 24 months preceding the backup. Because discharge of grease in quantities sufficient to restrict the hydraulic capacity of the collection system is prohibited, the City is not responsible for backups caused by such conditions.

5.3.2 Compensation Program

5.3.2.1 No-Fault Property Damage Program

The City of Pueblo maintains a "no-fault" property damage program to ease the burden upon residents who have experienced a sewer backup into a home or business by reimbursing certain costs associated with cleanup following a sewer backup. Compensation under this program is not required of the City, nor does it indicate or admit liability on the part of the City. The City's no-fault property damage program does not cover the cost of replacing carpeting or other damaged goods. It only covers those activities required to return a home or business to a reasonably safe condition by removing sewage and disinfecting those areas of homes or businesses that come into contact with sewage as a result of a sanitary sewer backup. This program is limited to the amounts lawfully appropriated therefore in the discretion of City Council, and no payment may be made unless unencumbered funds are available therefore.

5.3.2.2 Insurance Program

The City of Pueblo participates in liability risk sharing through CIRSA. CIRSA may make a determination as to whether the City of Pueblo is legally responsible for a sewer backup. Claims for replacement of carpeting and other items are processed by CIRSA. Normally, claims for replacement of items damaged by sewer backups are evaluated based on whether the City of Pueblo accomplished its goal of cleaning the sanitary sewer line in which the backup occurred within the 24 months immediately prior to the backup event. If the City did accomplish this goal, then there is no negligence on the part of the City and requests for reimbursement are normally denied.

5.3.3 No-Fault Property Damage Ineligible Costs

The following costs are not eligible for Reimbursement under the City of Pueblo's no-fault property damage program:

5.3.3.1 Replacing carpeting, tile, rugs, clothing, toys, furniture, or other household item
5.3.3.2 Refurbishing carpeting, tile, rugs, clothing, toys, furniture, or other household items
5.3.3.3 Re-installing carpeting, tile, sheet rock, doors, wainscoting, molding, plumbing fixtures, etc.
5.3.3.4 Cleaning air ducts associated with forced-air furnaces or central air conditioning
5.3.3.5 Remediation for mold

5.3.4 No-Fault Property Damage Eligible Costs

Provided funds are available, the following costs are eligible for Reimbursement under the City of Pueblo's no-fault property damage program:

5.3.4.1 Removing and disposing of carpet, carpet pads, tile, sheet rock, doors, wainscoting, molding, etc. damaged by a backup
5.3.4.2 Cleaning sub-flooring or concrete pad
5.3.4.3 Disinfecting sub-flooring or concrete pad
5.3.4.4 Removing liquids and solids deposited by the backup using pumps, vacuums, or similar types of equipment
5.3.4.5 Drying areas affected by the backup using blowers, fans, dehumidifiers, heaters, or other types of equipment

5.3.5 Reimbursement for Cleanup Costs

5.3.5.1 When damage to furnishings results from a sewer backup, homeowners and business owners are responsible for contacting firms that remediate water damage and for paying the costs of those services. In order to obtain reimbursement from the Wastewater Department for cleanup costs under the no-fault property damage program, homeowners and business owners must promptly submit invoices for cleanup services to the Wastewater Director.

5.3.5.2 All claims of damage or loss must be made in sufficient detail to allow the Wastewater Director to investigate the incident, make a detailed examination of the costs for which reimbursement is requested and determine whether such requests are eligible for reimbursement.

5.3.5.3 Customers being reimbursed for cleanup costs must sign a release and settlement agreement releasing and holding the City harmless from any other claims arising from the incident as a condition of receiving reimbursement.

5.3.5.4 Reimbursement for cleanup costs under the no-fault property damage program shall be limited to a maximum of $3,500.

5.3.6 Discretionary Reimbursements

5.3.6.1 In extreme circumstances, the Wastewater Director may exercise discretion to authorize limited reimbursement for damaged items based on circumstances of unusual need. Such circumstances may include, but may not be limited to, advanced age of household residents, chronic illness making occupants unusually susceptible to infection, or low or fixed income of household residents.

5.3.6.2 In extreme circumstances, at the discretion of the Wastewater Director, reimbursement may be made for the cost of a plumber or drain cleaning service. Citizens are strongly encouraged to contact the Wastewater Department before contacting a plumber so that the sanitary sewer collection system can be inspected and blockages cleared before unnecessary plumber's fees are incurred.

5.3.6.3 In extreme circumstances, the Wastewater Director may exercise discretion to authorize limited reimbursement for members of an affected household to occupy a motel temporarily until cleanup and disinfection has been completed. The total of such costs shall be limited to $150 per household member for each incident.

5.3.6.4 Discretionary reimbursements shall be limited to $1,500.00 per occurrences.

LIST OF REFERENCES

1. Sanitary Sewer Design Technical Manual, City and County of Denver, Department of Public Works, Wastewater Management Division, May, 1985.

2. Wastewater Division Rules for the Installation of Sewer Mains and Services, City of Colorado Springs, Department of Utilities, February, 1980.

3. Public Utility Improvements Rules and Regulations Regarding Standards and Specifications, City of Aurora, January, 1984.

4. Gravity Sanitary Sewer Design and Construction, WPCF Manual of Practice No. FD-5, 1982.

5. Water Quality Rules and Regulations, Wyoming Department of Environmental Quality.

6. Water and Wastewater Technology, Mark J. Hammer, John Wiley and Sons, 1986.

7. ISCO Open Channel Flow Measurement Handbook, Fourth Edition, Douglas M. Grant and Brian D. Dawson, Isco Environmental Division, 1995.

8. Inspector Handbook for Sewer Collection System Rehabilitation, National Association of Sewer Service Companies, 1993.

9. Uniform Plumbing Code, International Association of Plumbing and Mechanical Officials, 1997.

10. Handbook of PVC Pipe, Design and Construction, Uni-Bell PVC Pipe Association, 1982.

11. Standard Construction Specifications and Standard Details for Pueblo, Colorado, City of Pueblo, Department of Public Works, June.

12. Pueblo Municipal Code, Charter and code of the City of Pueblo, Colorado.

13. Design Criteria Considered in the Review of Wastewater Treatment Facilities, State of Colorado, Department of Public Health and Environment, June, 1994.