APPENDIX S

City of Glendale Sanitary Sewer Manual and Standards

City of Glendale

CITY OF GLENDALE, CALIFORNIA

SANITARY SEWER MANUAL AND STANDARDS

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CITY OF GLENDALE
SANITARY SEWER DESIGN MANUAL AND STANDARDS

1.0 BACKGROUND AND GENERAL INFORMATION

1.1 BACKGROUND

The City of Glendale (The City) is a Charter City located northeast of the City of Los Angeles in the San Gabriel Mountains. Glendale's population of approximately 200,000 resides in over 75,000 dwelling units within a 30.6-square-mile area. The City's current planning efforts estimate that Glendale's population is projected to reach approximately 225,000 by the year 2030.

The City of Glendale's existing wastewater collection system is comprised of four types of facilities. These facilities are:

1. Wastewater collection system pipelines,
2. Permanent wastewater monitoring metering stations,
3. One wastewater pump station, and
4. Co-ownership in a wastewater treatment facility.

The existing wastewater collection system within Glendale contains approximately 360 miles of underground wastewater pipelines. These pipelines range from 8 inches to 36 inches in diameter, with approximately 87% of the system being 8-inch. Wastewater collected in these facilities is conveyed primarily by gravity through a "trunk" wastewater pipeline system to regional interceptors for treatment at the Hyperion Treatment Plant (HTP) or the LAGWRP (Los Angeles Glendale Water Reclamation Plant), with sludge discharged to the Hyperion System.

The City of Glendale's existing wastewater system conveys wastewater in a southerly and southwesterly direction to the Los Angeles North Outfall Sewer (NOS), located along the Los Angeles River. Glendale's topography, in combination with the physical configuration of the piping and pumping system, has divided the City into seven major drainage basins or tributary areas.

Wastewater flows are accumulated by the wastewater pipeline system in seven district drainage basins and then measured at prescribed locations prior to final discharge to the NOS, the primary trunk line owned and operated by the City of Los Angeles to convey flow to the HTP and the Los Angeles-Glendale Water Reclamation Plant. In the last few years, the City installed permanent inline flow metering facilities to replace the permanent flume facilities that had served the City for 30 to 40 years. These metering stations provide ongoing flow data for billing considerations with the City of Los Angeles and are used as the basis of existing flow conditions for developing the Wastewater Master Plan Update by Kennedy-Jenks Consultants (K/J) (See Figure 2-2 for basin designations and outfall locations).

The majority of the City's wastewater collection system is composed of vitrified clay pipe (VCP) sewer lines. VCP is a commonly used sewer pipeline material and is generally considered to provide reliable service for over 80 years. As one of the older municipalities in its region, the City's wastewater system contains many older pipelines. In fact, approximately half of the wastewater system is over 75 years old.

The City owns, operates, and maintains one wastewater pumping station, the Doran Street Wastewater Pumping Plant (lift station) that lifts sewage from an existing 18" trunk sewer passing under the Verdugo Wash Flood Control Channel. This facility was originally constructed sometime around 1930 as a below ground, bi-level facility. The last major reconstruction of this lift station was in 1982 when upper level and ground level structures were added. The lift station is located at 967 W. Doran Street on the western edge of Glendale City limits and adjacent to the southeast corner of the confluence of the Verdugo Wash Flood Control Channel and the Los Angeles River.

1.2 GENERAL INFORMATION

1.2.1 PURPOSE OF MANUAL

The City of Glendale Sanitary Sewer Design Manual and Standards shall be cited routinely in the text as the " COG SS Manual" or just "SS Manual". The City of Glendale shall be cited as either the City or COG.

The purpose of the COG SS Manual is to provide a consistent policy under which certain physical aspects of sanitary sewer design will be implemented. The COG SS Manual shall govern all construction and upgrading of all public and private sanitary sewer facilities and applicable work within its service areas in the COG .

The permanent sanitary sewer facilities shall be provided to all property (legal lots of record created by a partitioning or subdivision of land per the City's Municipal Code). All new development shall provide for an extension of public sewer to upgradient properties.

The COG SS Manual cannot provide solutions for all situations. It is not intended to unreasonably limit any innovative or creative effort, which could result in better quality, cost savings, or both. Any proposed departures from the SS Manual will be judged on the likelihood that such variance will produce a compensating or comparable result, in everyway adequate for the user and resident.

Following from the above purpose, the SS Manual has the objective of developing a sanitary sewer system which will:

1. Be consistent with the City of Glendale General Plan, and the Sanitary Sewer Master Plan;
2. Be consistent with the City's Policies and Codes;
3. Be of adequate design to carry the expected flow, within their design life, and at sufficient depth to serve adjacent properties;
4. Have sufficient structural strength to resist all external loads which may be imposed;
5. Be of materials resistant to both corrosion and erosion through its design life;
6. Be economical and safe to build and maintain; and,
7. Prevent infiltration and/or inflow of ground and surface waters.

Alternate materials and methods will be considered for approval on the basis of these objectives.

1.2.2 REVISIONS TO THE SS MANUAL

It is anticipated that revisions to the COG SS Manual will be made from time to time. The date appearing on the title page of the COG SS Manual is the date of the latest revision. Users should use the latest issue for the work contemplated.

The design of the following are considered special problems and are not covered in detail in the SS Manual:

1. Sewage Pump Stations
2. Force Mains
3. Treatment Plants
4. Outfall Sewers
5. Regulating Devices
6. Flow Measurement Devices
7. Hydrogen Sulfide and/or Hazardous Gasses

Review and approval of the above special problems by the City Engineer shall be required. When requested by the City, full design calculations shall be submitted for review prior to approval.

1.2.3 REFERENCES

1. City of Glendale Municipal Code (CGM), Public Services-Title 13, Sewer System Title - 13.40
2. City of Glendale, CIP Specifications
3. City of Glendale Kennedy/Jenks Updated Wastewater Master Plan, July 2007
4. City of Los Angeles, Bureau of Engineering, Sewer Manual, June 1992
5. WEF Manual of Practice No. FD-5, Gravity Sanitary Sewer Design and Construction 1982, Water Pollution Control Federation, Washington, D.C. This is also available as ASCE Manual No. 60, ASCE, New York, New York.
6. Guidelines for the Implementation of the California Environmental Quality Act of 1970, City of Los Angeles, Revised 1-27-81.
7. WEF Manual of Practice No. 1, Safety and Health in Wastewater Systems 1983, Water Pollution Control Federation, Washington, D.C.
8. WEF Manual of Practice No. 7, Operation and Maintenance of Wastewater Systems, 1980, Water Pollution Control Federation, Washington, D.C.

1.2.4 STANDARD SPECIFICATIONS

Except where the SS Manual provides other directions Design and Construction shall be done in accordance with:

1. City of Glendale Municipal Code.
2. City of Glendale Specifications, General Conditions.
3. City of Glendale Standard Plans.
4. Standard Plans for Public Works Construction, latest edition
5. Standard Specifications for Public Works Construction, latest approved edition and supplement, Building News, Inc., Los Angeles, California.
6. Council Approved Conditions.

1.2.5 SEWER CONSTRUCTION PLANS

The sanitary sewer plans are identified with a number "3" followed by hyphen 3 or 4-digit number (3-XXXX). The number shall be taken from the Sewer Book Binder, next number in order after the last one recorded in the Book.

1.2.6 DIGITAL SEWER CONSTRUCTION PLANS

Most (but not all) of the construction sewer plans are available as a digital file. The images can be found at:

\\germ3\Images

Located within "Images" are folders named (actually numbered) corresponding to the type of plan found within, i.e. 1 for 1-xxx street plans, 2 for 2-xxx alley plans, 3 for 3-xxx sewer plans, etc.

Most of these images were converted into TIFF images from microfilm. Any new or missing plans are scanned as PDFs.

In order to map the City's utilities using the GIS system, the City has been divided into 189 GIS tiles. The electronic Sewer Atlas was created by mapping all 189 GIS tiles. The plans/GIS tiles can be accessed at:

U:\GISLib\Mapping PDFs\Sewer PDFs\24x36\24x36\TILE XXXX

1.2.7 DEFINITIONS AND TERMS

Abbreviation	Definition
AAF	annual average flow
ac	acre
ADD	average day demand
ADWF	average dry weather flow
APN	assessor parcel number
AWWF	average wet weather flow
BMP	Best Management Practices
BOD	biochemical oxygen demand
cf	cubic foot
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIP	Capital Improvement Program
D/d	depth to diameter
dia.	Diameter
DSP	Downtown Specific Plan
DU	dwelling unit
DU/ac	dwelling units per acre
EPA	U.S. Environmental Protection Agency
EADWF	Existing Average Dry Weather Flows
FADWF	Future Average Dry Weather Flows
FEMA	Federal Emergency Management Agency

FPDWF	Future Peak Dry Weather Flows
FPWWF	Future Peak Wet Weather Flows
fps	feet per second
GIS	geographic information system
gpad	gallons per acre day
gpcd	gallons per capita per day
gpm	gallons per minute
hcf	hundred cubic feet
HGL	hydraulic grade line
hp	horsepower
HTP	Hyperion Treatment Plant
I&I	Infiltration and inflow: The wastewater component caused by rainfall-dependent infiltration/inflow (RDI/I) and groundwater infiltration (GWI).
IWPP	industrial waste pretreatment program
JPA	Joint Powers Agreement
K/J	Kennedy/Jenks Consultants
KWH	kilowatt hours
LA	City of Los Angeles
PDWF	peak dry weather flow consists of peak sewage flows plus GWI.
PWWF	peak wet weather flow consists of PDWF plus RDI/I.
PF	Peak Factor is PDWF/ADWF.
RDI	rainfall dependent Infiltration consists of rainfall that enters the collection system through GWI.
RDI/I	rainfall dependent Infiltration/inflow RDI/I consists of rainfall that enters the collection system through both RDI (infiltration) and SWI (inflow) sources.
SERVICE LIFE:	The operational life of a sewage facility which should exceed the design period of the facility provided it is designed, constructed and maintained properly.
STORMWATER INFLOW (SWI):	SWI consists of rainfall runoff that enters the system through direct connections such as catch basins, downspouts and area drains.
TRIBUTARY AREA:	The tributary area of a sewage system consists of all areas which contribute flow to the sewer by gravity and/or force main discharges. These include sanitary sewer as well as I/I flows.

2.0 DETERMINATION OF DESIGN FLOW

2.1 PROJECTION OF FLOWS

Planning for the economical development of a sewer system requires information on current flows and forecasts of future flows. A sanitary sewer has two main functions: (1) to carry the peak discharge for which it is designed, and (2) to transport suspended solids so that deposits in the sewer are kept to a minimum. Therefore, it is essential that the sewer has adequate capacity for the peak flow and that it functions properly at minimum flows.

The peak flow determines the hydraulic capacity of sewers, pump stations and treatment plants. Minimum flows must be considered in design of sewers and siphons to insure reasonable cleansing velocities.

The elements required to determine the design flow in a sanitary sewer are as follows:

1. Tributary Area
2. Design Period
3. Population Estimate
4. Land Use
5. Per Capita Flows
6. Residential Flows
7. Commercial Flows
8. Industrial Flows
9. Major Point source Discharges
10. Infiltration/Inflow

The Wastewater System Master Plan prepared by Kennedy/Jenks Consultants for the City in 1998, and updated in 2007 (Updated Wastewater System Master Plan) evaluated each of the required elements. The Master Plan analyzed the City's existing wastewater system making recommendations for upgrades to handle future growth and development within the existing urban growth boundary. In the process, flow design criteria were established to meet future system demands.

2.2 DESIGN CRITERIA

Based on the inputs from various City Departments, recommendations provided in the Updated Wastewater System Master Plan prepared by K/J Consultants for the City, and general standards for the wastewater system design, the following parameters are the basis for design of the wastewater system in the City of Glendale:

2.2.1 TRIBUTARY AREA

The City has been divided into the seven major drainage areas. They are:

Colorado Flume
Chevy Chase Flume
Doran Pump Station Basin
Doran Flume
Elk Flume
Salem/San Fernando Flume
Tyburn Flume

For the sewer main to be designed, the drainage basin must first be identified. Superimpose the land use map on the drainage basin boundary, and determine the tributary areas of the specific land use located within the drainage basin.

Go to http://www.ci.glendale.ca.us/gmc/Maps for zoning maps.

2.2.2 DESIGN PERIOD

The design period is that length of time the capacity of the sewerage facility is anticipated to be adequate to service its tributary area. It must be determined before design of the facility is commenced. In general, the design aim is to have the system flow capacity period equal to the structural life of the pipe. VCP lasts 75 -100 years, however, the planning/zoning horizon is typically 20 - 30 years.

2.2.3 POPULATION AND LAND USE PROJECTIONS

Current zoning or projected land use classifications (as presented on the City's Zoning Map) shall be used in estimating projected sanitary sewage flow. A sewer flow coefficient has been calculated for each zone i.e. per land use classification. A sewer coefficient was derived by converting future wastewater flow projections for projected population and employment occupying the different zones per City's Zoning Map.

2.2.4 PER CAPITA FLOW

A. Existing Wastewater Flows

The City has installed seven permanent flow meters in the collection system to measure the volume of wastewater as it leaves the City, and is collected by facilities owned and operated by the City of Los Angeles (except for the Los Angeles-Glendale Wastewater Reclamation Plant which is owned 50% by Glendale). Based on wastewater flows and rainfall data gathered at these metering stations, average dry weather flow (ADWF), peak dry weather flow (PDWF), and peak wet weather flow (PWWF) factors were developed for each metering station and drainage basin.

B. **Future Wastewater** Flows

Future wastewater flow projections are derived by developing unit wastewater flow factors under current conditions and applying these factors to the population and employment projections developed by the City, provided in the Traffic Zone Area (TAZ) analysis data set, and as presented on the zoning map. (Downtown Specific Plan and General Plan).

The City's existing average annual flow in year 2007 is approximately 17 MGD. The City's total average annual wastewater is projected to increase to approximately 22 MGD by the year 2030, an increase of approximately 26%.

2.2.5 AVERAGE DRY WEATHER FLOW

Average Dry Weather flow (ADWF) includes average daily sewage flows and GWI. ADWF is the basis for calculation of PDWF.

$$Q_{ADWF}=Qave$$

$$Q\ ave\ (cfs)=Area\ (Acre) \times Sewer\ Flow\ Coefficient\ (cfs/Acre) \qquad Eq.\ (1)$$

2.2.6 SEWER FLOW COEFFICIENT

Sewer Flow Coefficients can be found in the SewerDesignCalculationTemplate, Appendix A of this Manual.

2.2.7 PEAKING FACTOR

A new peaking factor equation for the City was developed in the Updated Wastewater System Master Plan by KJ and is provided as follows:

Peaking Factor (PF) = -0.1615 Ln(Qave)+1.76, <u>(Q in mgd)</u> **Eq. (2)**

"Peak Factors" are the relationship between average daily dry weather flow and the highest dry weather peak of the year. As flows increase, the peak factor decreases.

2.2.8 PEAK DRY WEATHER FLOW

The Peak Dry Weather Flow (PDWF) includes peak sewage flows and GWI. PDWF is the basis for selecting a pipe size.

PDWF is determined by multiplying ADWF times a peaking factor.

$$Qpeak=(PF) \times Qave \qquad Eq.\ (3)$$

2.2.9 DESIGN CRITERIA FOR SEWER PIPE

The criteria for design of sewer pipe includes type/size sewer line, design period, design depth of flow and PDWF.

TYPE/SIZE SEWER LINE	DESIGN DEPTH OF FLOW* (d/D)
Trunk, interceptor, outfall and relief sewers - sewers **18-inch diameter and greater.**	0.67
Lateral sewers - sewers **15-inch diameter and smaller.**	0.5

*Depth of flow in the pipeline is based on (PDWF)
D = depth of flow
d = Pipe diameter

*Through the creation of the 2007 Master Plan Update, the City adopled new sewer design criteria. The two components of the new criteria are **depth to diameter criteria (D/d)**: all pipelines 18-inches and greater should not exceed **.67 D/d** under future peak wet weather conditions, and pipelines less than 18-inch should not exceed **.5 D/d**. These recommendations are based on the need to meet new State regulations for the use of a wet weather design criteria, the goal is to minimize potential sanitary sewer overflows (SSO's).

2.3 HYDRAULIC DESIGN

2.3.1 TYPES OF FLOW
(Also Refer To LA BOE SS Manual-Section F 240)

This section on hydraulics of sewers deals only with uniform flow employing the Manning Equation. Standard hydraulic handbooks should be consulted for special conditions. Since the flow characteristics of sewage and water are similar, the surface of the sewage will seek to level itself when introduced into a channel with a sloping invert. This physical phenomenon induces movement known as gravity flow. Most sewers are of this type. The flow in a pipe with a free water surface is defined as open channel flow.

Steady flow means a constant quantity of flow and uniform flow means a steady flow in the same size conduit with the same depth and velocity. Although these conditions seldom occur in practice, it is necessary to assume uniform flow conditions in order to simplify the hydraulic design.

There are times when sewers become surcharged, encounter obstacles requiring an inverted siphon or pumping. Under these conditions, the sewer line will flow full and be under head or internal pressure.

Three distinct slope lines are commonly referred to in hydraulic design of sewers:

1. The Slope of the Invert of the Sewer. This is fixed in location and elevation by construction. Except in rare cases, the invert slopes downstream in the direction of flow.

2. The Slope of the Hydraulic Gradient (H.G.). This is sometimes referred to as the water surface. In open channel flow, this is the top surface of the liquid flowing in the sewer. Except for a few cases, the hydraulic gradient slopes downstream in the direction of flow.

3. The Energy Gradient (E.G.). This is located above the hydraulic gradient, a distance equal to the velocity head which is the velocity squared divided by two times the acceleration due to gravity (v2/2g). This slope is always downstream in the direction of flow. For uniform flow, the slope of the energy gradient, the slope of the hydraulic surface and the slope of the invert are parallel to one another but at different elevations.

2.3.2 SUPERCRITICAL AND SUBCRITICAL FLOW (Also Refer To LA BOE SS Manual-Section F 242)

In the sewer system, the hydraulic study and flow type determination is important to meet the following hydraulic requirements:

1. The velocity must be sufficiently high to prevent the deposition of solids in the pipe but not high enough to induce excessive turbulence. The minimum scouring velocity is 2 feet per second (fps). Clay pipe is being used successfully where velocities exceed 20 feet per second.

2. Careful consideration should be given in the design of sewers to avoid hydraulic jumps. The rapid decrease in flow velocity across the jump may result in deposition of solids in the downstream conduit and the turbulence causes the release of sulfide gases held in solution.

3. Where changes are made in the horizontal direction of the sewer line, in the pipe diameter, or in the quantity of flow, invert elevations must be adjusted in such a manner that the change in the energy gradient elevation allows for the head loss.

4. Sanitary sewers through 15-inch diameter are normally designed to run half-full at peak flow and larger sewers are designed to run up to two-thirds full at peak flow.

In general, the design of sanitary sewers shall be based on steady uniform flow analysis employing the Manning Equation. The Engineer shall be able to identify flows type: supercritical, subcritical and critical flows. Because flows within 10 to 15 percent of critical depth are likely to be unstable they should be avoided. Computation of "critical depth" is necessary to determine whether flow may be supercritical or subcritical. Normal flow depth is compared with critical depth to determine if flow is supercritical or subcritical. If normal flow depth is above critical depth, the flow is subcritical. If normal flow depth is below critical depth, the flow is supercritical.

2.3.3 CALCULATION OF PIPE SIZE

After the design criteria have been determined the required pipe size may be calculated using Manning's formula.

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

where,

Q = Flow, cfs
A = Area of flow, sq. ft
R = Hydraulic radius (A/P), ft
n = Roughness factor

The pipe size is rounded up to the nearest standard size. To account for the discrepancy in the design period, pipes are sized to minimum 2 size diameters larger than the existing pipe and/or one additional pipe size is added. The minimum pipe size is 12" diameter for new installations.

2.3.4 MANNINGS ROUGHNESS COEFFICIENT "n"

A Manning's roughness coefficient of "n" = 0.013 shall be used for sizing gravity sewers. This Manning's roughness coefficient shall be used regardless of the type of pipe specified.

2.3.5 MINIMUM VELOCITY

Gravity sewers shall be designed for a minimum velocity of **(2) two fps** using the PDWF that exists at the time the pipe is placed into service.

2.3.6 MINIMUM SLOPE

The minimum scouring velocity is two fps (recommended three fps). The City Engineer approval must be obtained to use lower design velocities, except in the extreme upper reaches of the system with a few connections. In these cases, 8-inch diameter minimum pipe size and 0.0044 ft/ft minimum slope will govern except for the last upstream reach to a terminal maintenance hole where 0.0060 ft/ft minimum slope will govern.

Slope Rates -All grades for sewer pipe shall be given to a thousandth of one percent or slope to five decimal places.

Tabulated Values -Standard Minimum Grades

Diameter (Inches)	Minimum Grade (per cent)	Diameter (Inches)	Minimum Grade (per cent)
6	2.00 (H.C. only)	15	0.19
8	0.40 minimum	18	0.12
8	1.00 desirable	21	0.10
10	0.33	24	0.08
12	0.26		

When it is necessary to provide flatter grades than the standard minimum, pre-approval is required.

2.3.7 INVERT DROPS ACROSS MAINTENANCE HOLES (ALL PIPES THE SAME SIZE)

For straight through flow, the invert drop shall be computed by multiplying the diameter of the MH in feet times the average slope of the inlet and outlet sewers. When possible to attain, the minimum invert drop across a MH should be 0.10 foot.

For side inlet flow into the MH the invert drop across the MH shall be computed by multiplying the diameter of the MH times the average slope of the side inlet and outlet sewers and adding 0.10 foot. When possible to obtain, the minimum invert drop between the side inlet and the outlet should be 0.200 foot.

2.3.8 INVERT DROPS ACROSS MAINTENANCE HOLES (OUTLET PIPE IS LARGER THAN THE INLET PIPE) (same as the City of LA)

For straight through flow the drop across the invert of the MH shall be computed by multiplying the diameter of the MH times the average slope of the inlet and outlet sewers and adding the additional drop as shown in Table F255 of the City of LA Sewer Manual Bureau of Engineering.

ADDITIONAL INVERT DROPS ACROSS MAINTENANCE HOLE WHEN THE OUTLET SEWER IS LARGER THAN THE INLET SEWER PIPE SIZES 8-INCH THRU 15-INCH

TABLE F255 (in Foot)

Diameter Outlet Sewer (in inches)	Diameter Inlet Sewer (in inches)			
	6	8	10	12
8	0.08	-	-	-
10	0.17	0.08	-	-
12	0.25	0.17	0.08	-
15	0.38	0.29	0.13	0.13

In the above table the sewers are assumed to be flowing with the depth (D) to diameter (d) criteria, D/d = 0.50 and water surfaces at the same level. If the inlet pipe is 15-inch and smaller (D/d = 0.50) and the outlet pipe is 18-inch and larger (D/d = 0.67), a depth point of both pipelines shall be at the same level as shown in Figure F255. (This approximates maintaining the same hydraulic energy gradient from the inlet to the outlet pipe.

The maximum invert drop across MHs for sewers 15-inch and smaller shall be 0.60 foot for straight through flow and 1.00 foot for side inlet flow. When drop exceeds 26" for 8" vitrified clay pipe, a standard drop MH shall be constructed.

2.3.9 DROP SEWER MAINTENANCE HOLE

Drop sewer MHs may be specified when there is a junction of two or more sewers at a MH and there is a vertical difference of at least 2 feet between the sewer inverts. Parabolic vertical curves are preferable to make such connections. However, when such a curve is not feasible, a drop sewer MH may be specified. Inlet sewer size into the drop sewer MH shall be limited to 12 inches.

2.3.10 GRAVITY SEWER DESIGN COMPUTATION SHEET

Use The Sewer Design Calculation Template Computation Sheet Found in The Common File.

U:\Engineering\Design\Common Files\Project Management Sample Documents\2.3 Design Aids-Calcs\SEWER\SewerDesignCalculationTemplate.

For step-by-step procedure go to Appendix A, Example of Design Flow Calculation.

3.0 LOCATIONS AND ALIGNMENT OF SEWERS

3.1 LOCATIONS

3.1.1 **Streets** -Sewers shall be located usually along the center line of the street. When the line serves one side of the street only, it shall be located not closer than three (3) feet from the existing or proposed curb face. Sewers shall not be located between the curb and property line except in extreme cases where surface or subsurface obstruction will not permit another location.

3.1.2 **Alleys** -Sewer manholes shall not, as a rule, be located closer to the property line than three (3) feet, nor closer to the center line of alley than three (3) feet. Generally, sewer manholes shall not be located within three (3) feet of the alley flow line. If it is unavoidable, "pressure type" manhole F&C must be used.

3.1.3 **Double Lines** -Where street widths, street cross fall or underground obstructions cause design or construction problems, sewers may be built to serve each side of the street separately, or the sewers maybe placed in adjacent alleys. The relative cost of the two methods shall be considered in determining the location.

3.1.4 **Minimum Distance from Substructure** -Approval will be required for any sewer located less than three (3) feet from an existing or proposed pipe or conduit, except water mains, where the minimum distance shall be approved first by the water utility. In case of unavoidable interference with any existing utility pipe or conduit, arrangements with the utility owner shall be made for the supporting or moving of same at the earliest possible time. County Health Department approval may be required in the case of a water line.

3.1.5 **Right of Way** -In order to avoid the difficulties experienced in maintaining sewers located in Rights-of-Way, designers will use every effort within reason to locate sewers in streets or alleys, even though a greater depth is required. Usual conditions will rise where it will be necessary to deviate from this practice.

3.1.6 **Angles in Easement** -All angles on a proposed right-of-way sewer line shall be shown, except where proper ties to known points are shown sufficient for checking and stating the sewer location. When there is a difference between the measured and the calculated or recorded angle, the measured angle shall be used.

3.1.7 **Plotting House Connections** -House connections shall be plotted perpendicularly to the main sewer, if possible.

3.1.8 **House Connection Stations** -The location of all house connections shall be indicated by stationing with reference to the main sewer to which they will be connected. When the main sewer turns an angle and a house connection extends beyond a structure, indicate by light dotted black line the extension of the main sewer along which the stationing is taken, to its intersection with a dotted line perpendicular thereto, and meeting the curb line at the location given for the house connection sewer. When a house connection is at a skew to the main line, give two stations, one to the main line and one where the house connections meets the property line.

3.1.9 **House Connection Length** -On curved streets where the house connections extend to the curb line or the property line, the length shall be determined to the nearest foot, accurately scaling it from the plan and the length shall be shown along the line which defines the house connection sewer.

3.1.10 **Stubs** -The position and size of all stubs shall be shown on the plans.

3.1.11 **Skew Crossings** -Avoid long skew crossings under existing or proposed substructures.

3.1.12 **Storm Drain Crossings** -Plot storm drain in profile when paralleling or crossing sewer. Plot and callout elevations of sewer, house connections and storm drain at crossing points.

3.1.13 **Plot Utility Crossings** -except house services on profiles

3.2 MANHOLE SPACING

Sewer Pipe Size	Standard Spacing	Maximum Spacing
8" to 18"	300'	500'
21" to 36"	400'	700'
Over 36"	600'	800'

3.3 HORIZONTAL AND VERTICAL ALIGNMENT

Refer to LA BOE Sewer Manual, Section F320 and F321.41. A straight line alignment between MHs is proffered.

3.4 CURVED SEWER

3.4.1 Curved sewers should be used

1. To avoid crossing utility lines or crossing utility lines at too slight an angle

2. To reduce the number of manholes on curved streets

3. To minimize difficult construction problems

Special provisions governing the use of curved sewers

a. The sewer alignment must be based on a center line survey showing all angles, curve data and tangent distances with ties to control points.

b. On a sewer 27 inches or smaller in diameter, the following will be permitted between two manholes: one simple curve, either horizontal or vertical, curves need not begin or end at a manhole, but it is preferred.

c. On a sewer 30 inches or larger in diameter, compound curves or a combination of curves and tangents maybe used. Special attention shall be given to the numbers and location of manholes on such sewers to ensure normal maintenance operations.

3.4.2. No curve radius, vertical or horizontal, shall be less than 150 feet for pipe 15 inches in diameter or less, unless special lengths of pipe is specified on the plans. Larger pipe shall be beveled to fit the particular alignment shown on the plan. Pipe lengths will be delineated on all curves.

3.4.3 Manholes shall be arranged in such a manner that a survey crew can retrace the sewer main with reasonable accuracy without ties, using the center of the manhole ring and covers as a control points.

3.4.4 Plans of proposed curved sanitary sewers shall have the following note in a conspicuous place on the plans:

"All curved sewer lines shall be 'balled out' by the contractor in the presence of the City Engineer or his authorized representative before final acceptance of the completed line by the City. Should this procedure indicate an obstruction or break in the pipe, it shall be the Contractor's sole responsibility to locate the obstruction or break and to repair and repeat 'balling out' until this test indicates to the satisfaction of the City Engineer that the line is clear and unbroken.

3.5 SEWER DEPTHS

3.5.1 **Mainline and House Connections Depths** -Except as influenced by other considerations, main line sewers shall be designed for an 8 foot depth to secure house connection sewer depths of 6 feet at the curb line or property line, whichever controls.

3.5.2 **House Connection Depths** -The figure in a circle on the plans adjacent to a house connection station indicates the depth in feet below the existing curb to which the invert of the upper end of the house connection shall be constructed. If no depth is indicated, the invert of the upper end of each house connection shall be built to the elevation shown on the profile, or if no such elevation is shown, to a depth of 6 feet below the top of existing or future curb, provided, however, that a minimum 2% fall towards the sewer main is maintained along the entire connection.

3.5.3 **Open cut, Tunnel, or Jacking** -All sewers shall be designed in open cut, except when conditions warrant the use of tunneling or jacking such as congested traffic, utility interference, excessive depth, sewer Rights-of-Way to avoid interference, or under railway tracks where it is impossible to use a trenching machine.

4.0 SEWER MATERIALS AND STRUCTURES

4.1 TYPE AND CLASS OF PIPE

1. **Clay pipe** -Unless otherwise specified on the plan or the profile, sewers shall be constructed of high strength clay pipe in accordance with Section 207-8 of Standard Specifications for Public Works Construction.

2. **Cast Iron Pipe, Ductile Iron Pipe** -Cast iron pipe or ductile iron pipe may be specified where it would not be satisfactory to use clay pipe due to unusual conditions.

3. **Plastic Pipe**-The use of plastic pipe is subject to the City's Engineer approval.

4.2 SEWER PIPE JOINTS

All sewer pipe and box joints shall be rootproof, gasproof and watertight. Unless otherwise provided for on the plans or Special Provisions, the joints shall be as per SSPWC.

Type "D" Joint-Type D shall be used for 6" plain end VCP with maximum deflection less than 2 ½ degree.

Type "G" Joint- Type G shall be used for Bell and Spigot (B&S) VCP.

Type "Z" Joint -Type Z shall be used for VCP field closures and to adapt pipes of different materials or pipes having different outside diameters. It shall be applied to 4"-12" diameter pipe only.

4.3 SEWER MAINTENANCE HOLE (MH)

Unless otherwise specified on the plans or Special Provisions, MHs shall be as per SPPWC.

New precast concrete MHs shall be lined on the interior surfaces with a plastic or an approved protective coating. The standard test to determine the coating's resistance to corrosion may be found in Subsection 210-2.3.3 of the SSPWC.

4.4 SEWER MAINTENANCE HOLE FRAME AND COVER (MHF&C)

A minimum size 27 inch maintenance hole frame and cover (MHF&C) shall be installed on every new sewer MH. The size (MHF&C) shall vary with the maximum pipe size connected to the MH as indicated in Table F 462.

A 36-inch MHF&C may be used to provide a large access cover when necessary for maintenance (e.g. very shallow MHs). Because of the weight issue, 36-inch MHF & C shall consist of two concentric rings (24-inch ring within 36-inch.) Most local supplier carries these MHF & Cs.

Pressure MHF&C shall be required when the hydraulic grade line of the sewer may rise to within 1 foot of the top of the maintenance hole.

4.5 SEWER MAINTENANCE HOLE SIZE

The MH size is dependent on the largest pipe size connected to the MH. Table below lists the minimum required MH inside diameter with respect to pipe sizes connected to the MH. The Engineer may increase the MH to the next largest size upon his discretion with the approval of the City Engineer.

Sewer Pipe Size (Inches)	Min. MH Inner Dia.	Size Frame & Cover (Inches)
8" to 15"	4 feet	Standard 27"
18" to 30"	5 feet	Standard 36"
Over 33"	6 feet	Large 36"

Min. MH Inner Dia.	MH Depth
5 feet	Over 20'
6 feet	Over 30'

Because of the weight issue, 36-Inch MHF & C shall consist of two concentric rings (24-inch ring within 36-Inch.) Most local supplier carries these MHF & Cs.

4.6 SEWER CONNECTION (CORE DRILLING)

On occasion, it may be necessary to connect a smaller sewer to an existing larger sewer pipe at a location other than an existing maintenance hole for economic reasons. If the connection cannot be made directly at a maintenance hole, the opening in the existing sewer shall be made with a core drill. The connection shall be made using "Tap-N-Tee" saddle or approved equal. (See SSPWC under "Connections, Junctions, Branches, and Spurs").

4.7 BLANKET PROTECTION FOR PIPES

When conduits or other facilities are to be constructed above and in close proximity to existing sewers, there is some probability and concern that the proposed excavation or construction will damage the sewer line and thus, shall be protected by a concrete blanket for the full width of the excavation. SPPWC shows concrete blankets for pipes. Also, see SPPWC "House Connection Remodeling".

4.8 TUNNELING, JACKING, MICROTUNNELING AND DIRECTIONAL DRILLING

Tunnels, jacked casings, microtunneling and directional drilling are usually, but not always, more complex and expensive than open trench construction. See SSPWC in conjunction with such work. Also, see applicable sections of the California Code of Regulations (CCR), Title 8, Industrial Relations, Chapter 4, Division of Industrial Safety, Subchapter 20, Tunnel Safety Orders for additional requirements. For purposes of the CCR, **Jacking Installations are considered the same as tunnels.** California State law governs when there is a conflict between it and City policies and requirements.

4.9 TUNNEL CLASSIFICATION

After the decision to construct a tunnel or a jacked casing has been made, the Engineer shall submit all data necessary for submittal to the California Occupational Safety and Health Administration (CalOSHA) in accordance with the CCR.

Data to be submitted includes, but is not limited to:

1. Plans and Specifications
2. Geologic Report
3. Test hole and soil analysis log along the tunnel alignment
4. The possibility of encountering flammable gases or vapors and recommendations if they are expected to be encountered

CalOSHA will review the submittal and designate the proposed tunnel as one of the following classifications:

1. Nongassy
2. Potentially gassy
3. Gassy
4. Extra hazardous

CalOSHA's classification shall be included on the Plans or in the specifications.

4.10 SEWAGE GAUGING AND METERING STATION

In the last few years, the City installed permanent, continuous inline flow metering facilities. Some of these electronic flow measuring devices were installed in existing Parshall Flumes that have been serving the City for 30 to 40 years. These metering stations provide ongoing flow data for billing considerations with the City of Los Angeles.

The existing flow in year 2007 and future flow as described in the section "Per Capita Flow" is summarized in table below:

	Existing WW (Year 2007)		**Future WW (Year 2030)**		**Wet Flow (5 Year)**
Metering Location	**ADWF (MGD)**	**PDWF (MGD)**	**ADWF (MGD/%)**	**PDWF (MGD%)**	**I & I (MGD) (b)**
Colorado Flume	4.07	6.06	6.01 (148%)	8.60 (142%)	2.50
Chevy Chase Flume	3.25	5.14	3.61 (111%)	5.52 (107%)	1.40
Doran Pump Station Basin	0.62	1.15	1.76 (284%)	2.94 (255%)	0.20
Doran Flume	4.00	6.04	4.29 (107%)	6.48 (107%)	1.70
Elk Flume	3.50	5.39	3.76 (107%)	5.73 (106%)	3.70
Salem/San Fernando Flume	1.10	1.47	1.60 (146%)	2.29 (156%)	0.60
Tyburn Flume	0.76	1.38	0.84 (110%)	1.51 (109%)	0.80
Total Flows	**17.30**	**26.62**	**21.87 (126%)**	**33.07 (124%)**	**10.90**

Notes: Percent increase is the increase in flow per basin going from existing to future conditions.

Information relative to the types of the current flow measurement devices, including sewage gauging data, may be obtained from the Public Works Environmental Section. In 2005, during recurring rains, flows at the flumes were measured and compared to dry weather flows. This information allowed for I&I flows to be determined for each drainage basin.

4.11 HOUSE CONNECTIONS

House Connections (HC) conveys sewage from the property line to the main line sewer. HCs serve residential, commercial and industrial facilities. The entire HC is under the jurisdiction of the property owner as controlled through the permit process. The segment located on private property is under the jurisdiction of the Building and Safety Department; and within the public right-of-way by P.W. Engineering.

When not constructed as part of a project, HCs are installed under a permit in conformance with The City of Glendale Municipal Code (CMG), Public Services-Title 13, Sewer System Chapter 13.40.

The minimum size of an HC shall be 6 inches. The maximum size of an HC shall not exceed a diameter 2 inches less than the diameter of the main line to which it is being connected. HCs shall be designed for the Peak Dry Weather Flow (PDWF) from the lots connected. For single family residences, smaller apartment buildings and some commercial and industrial facilities (single lots) a 6 inch HC is adequate and the application may be submitted without supporting calculations and details.

HCs for large facilities (commercial/industrial size or more than a single lot) shall be designed in detail by a registered civil engineer. Complete plans and supporting data shall be submitted with the application for review and approval. Flow capacity in the main line and downstream collectors, interceptors and outfall sewers shall be checked. No permit shall be issued if there is inadequate flow capacity in existing sewers. If additional sewer flow capacity is necessary, the permittee shall be required to assume all or part of the costs for constructing such sewers. The City's Engineer office maintains "As-Built" HC data on the Sewer Maps in the Sewer Atlas.

1. **Minimum Grade for House Connection** -The standard grade for a house connection shall be 2% but a grade of 1% may be permitted in exceptional cases.

2. **Rise of "Y" and 1/8" Bend** -The normal rise of the "Y" and "1/8" bend for house connection sewers above the main sewer shall be as follows:

Main sewer Size In Inch	"Y" & "1/8" Bend - Rise in Ft	Main Sewer Size in Inch	"Y" & "1/8" Bend - Rise in Ft
8	0.9	18	1.6
10	1.0	21	1.8
12	1.2	24	2.1
15	1.4		

When maximum depth of house connection is required, the "Y" and "1/8" bend may be laid flat, in which case the flow line of the "1/8" bend will be the difference in radii plus 1/4" above the main sewer line.

3. **"Y" Location and Data** -Number and Standard Location -One "Y" shall be provided for the short frontage of each lot and in general, One "Y" to every fifty (50) feet of unsubdivided frontage. Two "Y's" shall be provided for the long frontage of a lot.

   Unless there is a specified reason to do otherwise, one "Y" shall be provided, on each side and directly in front of the terminal structure of any sewer extension.

4. **Saddle Connections**-Whenever a connection is required, and a "Wye" or "Tee" spur for the connection does not exist, a saddle connection shall be constructed (type "Tap-N-Tee" or approved equal). Saddles specified on a City's project shall be installed by the City's contractor. Saddles installed under the permit (CMG, Public Services-Title 13, Sewer System Chapter 13.40 shall be installed by the permittee's contractor only after the existing sewer has been adequately exposed by the permittee's contractor and inspected by the City's PWD Construction Inspector.

4.12 TRENCH EXCAVATION, BEDDING AND BACKFILL

See Construction requirements for trench excavation, bedding and backfill in the applicable sections of the SSPWC and as shown on the LA Standard Plan S-251. Usually, these requirements are adequate. Where special conditions warrant, additional details may be shown on the project plans, or the Special Provisions may include such special requirements. Slurry backfill may be required in arterial roadways.

4.12.1 BEDDING REQUIREMENTS FOR VCP

Bedding requirements for VCP shall be in accordance with Figure F 490.1 "Bedding Requirements for Clay Pipe in Trenches". When the graph indicates that reinforcement is required, the plans shall call for construction of the appropriate bedding as shown on the LA Standard Plan S-251 "Pipe Laying in Trenches".

4.12.2 BEDDING REQUIREMENTS FOR PIPES OTHER THAN VCP

If a situation arises to install the pipe of different material than VCP, bedding requirements will be considered on a case-by-case basis.

4.13 TRENCH RESURFACING

Temporary and permanent resurfacing shall be per SSPWC and per the City's Standard Plan No. 25-153.

5.0 PREPARATION OF PLANS

5.1 PLAN LAYOUT

1. **Drawing Size & Plan Material** -Sewer Plans shall be drawn with waterproof ink on polyester base film with outside dimensions of 24" X 36".

2. **Standard Title Block** -The City of Glendale Standard Title Block shall be located in the lower right hand corner of the first sheet. Job limits description in the title shall be referenced to the nearest intersecting street or streets.

3. **Plan and Profile Direction** - Keep the northerly or easterly end of the profile and plan at the right hand end of drawing.

4. **Vicinity Map** -A vicinity map shall be shown on the first sheet of the plans with nearby streets indicated so that the location of the project may be easily determined. If a subdivision is involved with the sewer plans, its boundary and tract number shall also be shown on the vicinity map.

5. **Plan Number** -Plan numbers shall be assigned by the City Engineer to the drawing when the initial check is made.

6. **Sheet Numbers** -The individual sheets in a set of sewer plans shall be numbered.

7. **Profile Stations and Elevations** -Each 100-foot vertical line shall be numbered by stations, and each 10-foot horizontal line shall be numbered by the elevations which pertain to the particular profile. Stationing shall continue from existing stationing on file in the office of the City Engineer.

8. **Dimensions** -All streets and alleys adjoining the proposed sewer work shall be shown, giving the name and width of each. All lots, or other subdivisions, along the proposed sewer, including tract names, block and lot numbers, shall be shown.

9. **Scales** -The horizontal scale shall be 1" = 20', or 1" = 40' and the vertical scale 1"= 4', except for steep hillside areas, where the vertical scale 1"= 8' may be used.

10. **Street Names** -Street names shall be shown on the plan.

11. **Bench Mark** -The elevation, location and referenced must appear on every plan.

12. **North Arrow** -North arrow shall be large enough to be seen immediately and point up or to the right.

13. **Registered Civil Engineer's Signature** -The signature and R.E. number of the Registered Civil Engineer under whose direction plans were prepared shall appear on all the plans.

14. **City Council's Adoption and Approval (City Projects)**

15. **Engineer's cost estimate with unit prices and quantities** – For bonding use. (Private Projects)

16. **Copy of topographic survey or ALTA survey** – Provide copy of survey of existing utilities for cross reference.

5.2 EXISTING IMPROVEMENTS

1. **Existing Utilities** -All existing utilities shall be indicated on the street, in accordance to records in the office of the City Engineer and field survey information. Reference plan numbers shall be shown.

2. **Existing Improvements** -All surface and subsurface features which are in the R.O.W. and those adjacent to the R.O.W. that will affect the sewer construction shall be delineated on the plan.

3. **Existing Elevations** -All existing elevations determined by surveying shall be bracketed when used on the plan or the profile. Lines showing existing elevations on profile shall be indicated as dashed lines.

4. **Field Checks** -All sewer plans will require field checks, whether designed by this office or by a private engineer.

5. **Field Data Preference** -Data for calculations shall be taken from field books in preference to recorded figures and angles, and all calculations shall be checked.

6. **Curbs** -All curbs along the sewer line shall be shown, with the distance out from the center line, and be labeled existing or proposed.

7. **Ground Line** -The ground line over the proposed sewer shall be indicated by a dashed line. Where a fill is known to have been made, the earliest known ground line also shall be shown and labeled with the date of the survey.

6.0 SEWER CONSTRUCTION AND INSPECTION

6.1 GENERAL

Except for permit projects (Private Projects), City sewers shall be constructed by a contractor(s) under contract with the City, i.e. the Public Works Department. The contract shall be awarded to the lowest responsive bidder in competitive bidding procedures conducted by the PW Department. Upon award of the contract, PW Department shall be responsible for construction management and inspection. The contractor is responsible for the construction staking and survey through the entire project.

The Engineer is essentially a technical adviser and coordinator during construction. Design and plan change orders needed during construction remain the responsibility of the Engineer. Other agencies, including City agencies, may be involved during construction. Good public relations, coordination and liaison shall be a requisite in the Engineer's duties during construction. The Engineer in the SSPWC implies the City Engineer. During construction the Project Engineer represents the City Engineer.

6.2 CONSTRUCTION INSPECTION

PWD Construction Inspectors are responsible for inspecting services provided by the City. A Inspector shall be present during any activities related to the project to verify that material and construction are meeting specifications.

The Construction Inspector shall at minimum perform the following duties:

1. Monitor work progress and performance testing as deemed desirable by the Engineer
2. Inform the Engineer of all proposed plan changes, material changes, stop work orders, or errors or omissions in the approved plans or specifications as soon as practical
3. Maintain a Construction Project Book
4. Submit a Daily Construction Report to the Engineer

Daily Construction Report shall address at minimum:

1. Project Name Number (Specifications No.)
2. Date and time of site visit
3. Weather conditions
4. Description of construction activity
5. Statement of directions to change plans, specifications, stop work, rejection of materials or other work quality actions
6. Public agency contacts
7. Perceived problems and actions taken
8. General remarks related to construction activities
9. Record all material, soil and compaction tests
10. Citizen contact or complaints

5. Report at the end of each month the amount of work completed to enable Engineer to create a progress payment to pay the Contractor.
6. Assure that the contractor notifies police, fire, school bus, and public transportation officials of proposed street closures or traffic detouring or disruption
7. Verify that traffic control signing is in place prior to the start of construction, and in compliance with the City approved traffic control plan.
8. Verify grade and alignment of sewer a minimum of once for each run between manholes.
9. Verify pipe size and class of bedding, backfill, manhole, and that material and construction meet specifications.
10. Be present at air test and supply City with copy of air test results
11. Be present at compaction testing of trenches and supply City with copy of results
12. Be present at pavement resurfacing of trenches
13. Monitor CCTV video Inspection
14. Obtained a Daily Contractor Report
15. Be present at the Final Project Inspection

6.3 MATERIAL INSPECTION AND APPROVAL

Materials shall be in compliance with the requirements of SSPWC and/or General and Special Provisions of the City's Specifications. The City's Specifications shall prevail over the requirements of SSPWC. Refer to General Provision of the City's Specifications (Article 8-Material and Article 9-Submittals) for material requirements.

Geotechnical inspection of trench stability and backfill compaction is performed by the City's contracted private geotechnical consultant.

6.4 REVISION OF PLANS

Revisions to plans become necessary due to unforeseen conditions occurring during construction. All problems occurring during construction shall be investigated and resolved to the satisfaction of all affected parties before revising the plans. The revisions shall be coordinated by the Project Engineer in conformance with change order procedures.

6.5 SHEET ADDITIONS, DELETIONS AND SUBSTITUTION

Refer to LA BOE Section F 684 SHEET ADDITIONS OR DELETIONS and Section F 684.3 SHEET SUBSTITUTION for procedure when it becomes necessary to do so during construction phase.

7.0 PUMPING PLANTS AND FORCE MAIN

The City owns, operates, and maintains one wastewater pumping station, the Doran Street Wastewater Pumping Plant (lift station) that lifts sewage from an existing 18" trunk sewer passing under the Verdugo Wash Flood Control Channel. The City's Wastewater Maintenance Services is responsible for operation and maintenance of the plant. This plant is in the process of a comprehensive rehabilitation and expansion.

Since the design of pumping plants and force mains is a complex activity which requires the expertise of various design disciplines, design of an upgrade of the pumping station shall be done by outside consultants.

For general guidelines, references and design standards refer to the **LA BOE-Sewer Manual, Section F700.**

8.0 PROCEDURE FOR EMERGENCY SEWER REPAIR

8.1 MAINTENANCE AND OPERATIONS

Continued inspection, maintenance and rehabilitation of the wastewater collection and pumping system are integral components of a utility operation and are required to extend the useful life of infrastructure facilities and prevent system failures. Ongoing and proactive maintenance and operations (M & O) must be performed to limit the City's liability from system backups into private property and to protect the environment from overflows and spillage.

8.2 SEWER COLLECTION SYSTEM MANAGEMENT

The City's Public Works Maintenance Services Section (Maintenance Services) is responsible for the day-to-day M & O of the City's owned wastewater facilities (excluding LAGWRP) and the local storm drainage system. The Public Works Maintenance Services is compromised of:

1. Wastewater Maintenance Superintendent (MS)
2. Sewer Crew Supervisors (SCS)
3. Sewer Maintenance Workers (SMW) (typically three two-man crew).

8.3 OPERATIONS

The primary M & O activity of the City's Maintenance Services is:

1. Wastewater Pipeline Cleaning
2. Wastewater Pipeline Video Inspection
3.. Wastewater Flow Monitoring
4. Wastewater Pump Station Inspections and Routine Maintenance
5. Wastewater Service Calls & Emergency Response
6. Storm Drainage Pipeline Cleaning and Inspection
7. Storm Drainage Service Calls & Emergency Response

The wastewater pipeline cleaning & video inspection compromise the majority of field O & M activities throughout the 12 sewer maintenance districts. The City has established an annual on-going video inspection program, Cleaning and Video Inspection of Sewer Main Lines. The program has been funded through the various CIP projects. Upon completion of video-inspection in the assigned district and identification of the lines in need of repair, the sewer repair is addressed through another annual CIP project "Miscellaneous Sewer Repair". In general, the costs associated with the City's Maintenance Services section activity and CIP projects are borne by the City's Sewer Fund.

8.4 EMERGENCY SEWER REPAIR WORK

The City is in the process of executing contractual agreements with a number of private contractors that will be utilized to respond to emergency sewer repair work. Additionally, emergency sewer repair work is added to underground contracts. In both cases, the City requests quotes from 2 to 4 contractors to ensure a cost effective repair.

Sewage Spill Telephone Notification:

Should a sewage spill occur, the incident shall be immediately reported to either one of these two City Divisions:

1. Sewer Maintenance Services	(818) 548-3950
2. Fire Department Dispatch Center	911

9.0 REHABILITATION DESIGN

Refer to LA BOE-Sewer Manual, Section F900

This section provides guidelines and procedures to assist in the investigation and design to improve sewer system performance through rehabilitation.

Except as modified by the SSPWC and the City's CIP Specifications, Special Provisions, Section-Pipeline System Rehabilitation, U:\Engineering\Design\Common Files\CIP Project Specifications\Standard Specifications - August 2007 Update) materials and method referenced in the LA BOE-Sewer Manual, Section F900 shall be submitted to the Engineer for the approval prior the use in the City.

Table of Contents of Section 900 can be found in Appendix A as a reference.

APPENDIX A

Tables and Graphs

EXAMPLE SS-1

SANITARY SEWER PROJECTED FLOW CALCULATION

Step 1:

Define the basin(s) boundary which contributes flow to the sewer to be designed.

Use existing GIS tile maps (U:\Engineering\Design\Common Files\AutoCAD Files\Tiles From GIS) to draw property lines, street lines, sewer mains, laterals and manholes, building, etc. Sewer pdf maps from Sewer Atlas can be used for determining flow direction, sewer size and slope. Use "As-Built" drawings and any other pertinent information to support and verify gathered/downloaded information.

Step 2:

Define land designation (zoning) within a drainage basin by superimposing the land use map on the drainage basin(s) boundary. Starting at the upper end, start adding areas of the same land use (zoning). Determine total tributary area for each specific zoning area for the sewer under review. Area shall be expressed in acres.

The latest zoning map can be downloaded from the City's site:
http://www.ci.glendale.ca.us/gmc/Maps

Step 3:

Determine the Average Dry Weather Flow (ADWF) for the sewer.
ADWF is obtained by multiplying a total tributary area of each specific zone by a sewer flow coefficient.

$$ADWF=Q_{ADWF}=Qave$$

Q ave (cfs)=Area (Acre) x Sewer Flow Coefficient (cfs/Acre) Eq. (1)

Each zoning area has assigned sewer flow coefficient. Go to Appendix A, Table SS-1 to find a sewer flow coefficient for different zones.

Starting at the upper end of the sewer under review, add projected average flows.

Step 4:

Determine the Peak Dry Weather Flow (PDWF)

As the projected average flows from each drainage area are totaled, multiply it by the appropriate peaking factor to determine the peak flow for each reach of the line.

Peaking Factor (PF) = -0.1815 Ln(Qave)+1.76, <u>(Q in mgd)</u> Eq. (2)

Qpeak=(PF) x Qave (cfs) Eq. (3)

These values (Qpeak) are the design capacities for the proposed sewer.

Note: Qave expressed in cfs in equation (1) should be converted to mgd to be used in Peaking Factor equation (2).

1cfs=0.64632 mgd

See Sample of Flow Estimating Calculations (TABLE SS-2).

(Go to U:\Engineering\Design\Common Files\Project Management Sample Documents\2.3 Design Aids-Calcs\SEWER\SewerDesignCalculationTemplate)

Area 01 average flow is totaled and converted to Qpk in Manhole A(MH No. 020349). Area 2 is added at MH B (No. 010334). Area 3 is added at MH C (No. 010351) and so on. The areas are also served by a number of house connection sewers directly tributary to the study sewer all along the Drainage Area. To simplify calculations the flow from the areas contributing to the line under review, can be lumped together and added at one point (outfall MH).

If a relief sewer was proposed that would intercept a portion of this Study Area the average flow from Drainage Areas or parts of Drainage Areas tributary to the new line would be added to the relief line and subtracted from the existing line.

Design Requirements

After flow estimates have been prepared, and the layout of the system has been determined, the next step is to establish the slope for each line. The profile sheets show the surface elevations, subsurface structures and any other control points, such as house connections and other sewer connections.

Using the profile sheet, a tentative slope of the sewer is determined beginning at the lower end and working upstream between street intersections or control points. The slope is obtained by drawing a preliminary profile showing control points, such as, sewers to be intercepted, major sub-structures, ground lines, outlet or following the slope of the existing sewer pipe, etc.
The slope is located as shallow as possible to serve the adjacent area and tributary areas with consideration to street grade, depth requirements and any control points or obstructions.

Selecting the Sizes for the New Sewer Line

Knowing the peak flow and the tentative slope, a tentative pipe size can be selected for each reach. Using the Manning's Equations and design criteria (slope, minimum velocity, dept to diameter ratio (D/d), a final pipe size can be selected.
For small pipe up through 15-inch diameter, D/d=0.5 (pipe is flowing half full at peak flow). For pipes 18-inch and larger sizes, D/d=0.67 (pipe is flowing two-thirds full at peak flow).

As a final check, plot the pipe lines on the profile, set the outlet elevation and work upstream through each confluence, making sure there is adequate clearance for substructures, and that the line meets all other controls. The pipe size will have to be rechecked if the slope has been changed for any reason.

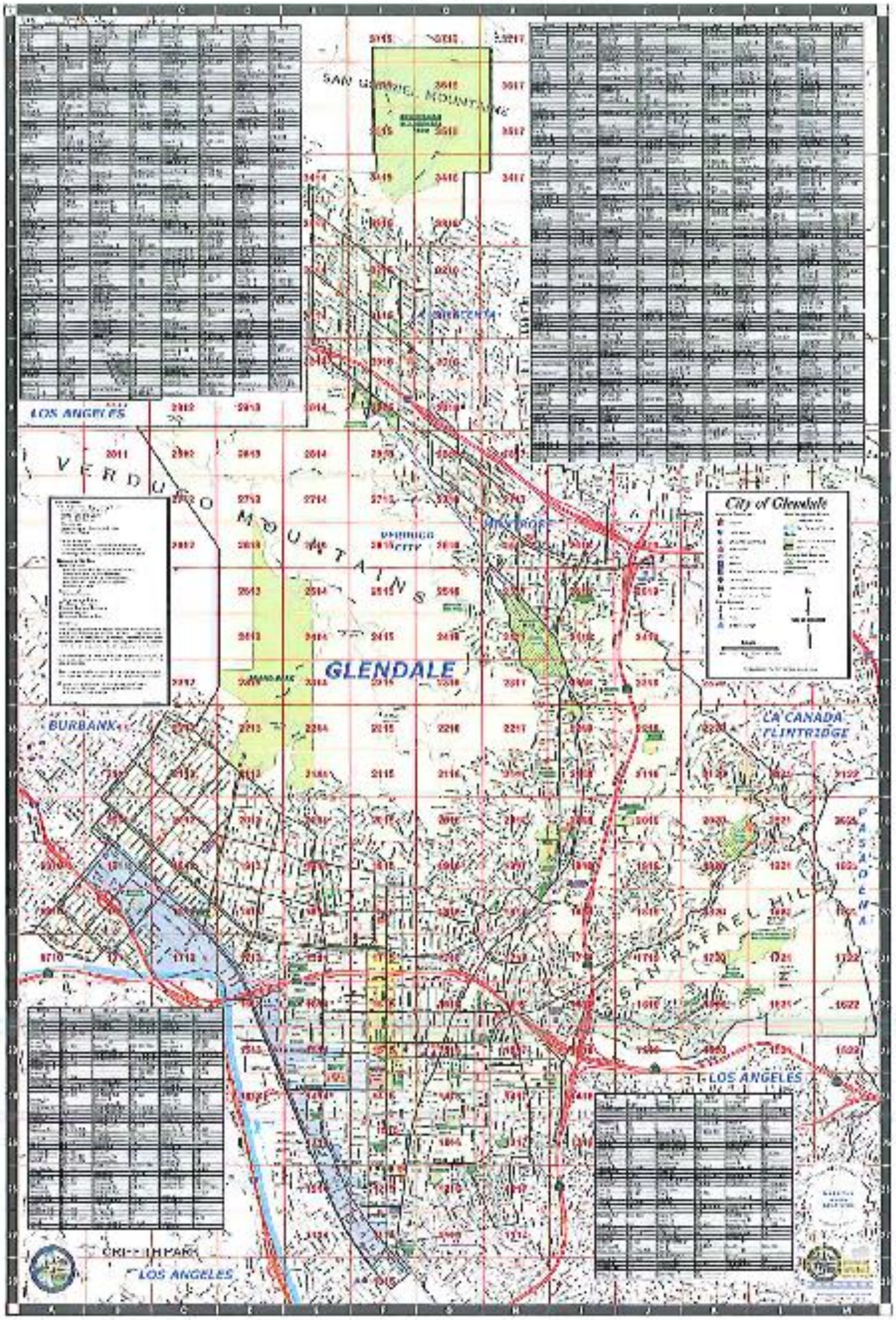
Knowing the quantity of flow and the pipe size, the velocity can be calculated using the Manning Equation. (Go to U:\Engineering\Design\Common Files\Project Management Sample Documents\2.3 Design Aids-Calcs\SEWER\SewerDesignCalculationTemplate)

The velocity head can be calculated to give the Energy Gradient. In many cases, especially with large diameter sewers, it is necessary to carefully plot the energy gradient of the sewer to determine that the hydraulic design requirements are met.

In these cases, start at the downstream end of the profile and mark the energy gradient at that point. Where the flow enters another sewer it will be the energy gradient of that sewer.
A line to represent a tentative location for the energy gradient for the first section of sewer being designed is then drawn upstream following the available surface slope to the next control point on the profile. This could be a point where flow is added, a street intersection, an abrupt change in surface slope or other control points. Care must be taken to see that the final design of the sewer provides adequate cover and that the sewer clears all subsurface obstructions. The profile can now be finalized.

After the final size and grade are establish, the Engineer can transfer data to sheet as shown on Figure F256 to summarize design flows including ADWF and PDWF, resulting velocities, normal and critical depth. The sheet includes identification of MHs by number and station. It also shows sewer characteristics including length, slope, pipe size and fall.

City of Glendale



Proposed New City Sanitary Sewer Coefficients

TABLE SS-1

Based on Kennedy Jenks Coefficients & Adjustments to old 1972 City Coefficients

Zoning	OLD City Coef (cfs/Ac)	K-J Coef (gpd/Ac)	K-J Coef (cfs/Ac)	% K-J / City	K-J Coef Extended	Proposed 2007 City Coefficients	Current Zoning http://www.ci.glendale.ca.us/gmc/Maps
C1	0.008				0.0056	0.006	Neighborhood Commercial
C2 (& Chevy Chase)	0.008				0.0056	0.006	Community Commercial
C3	0.008	2332	0.0036	45.10%	0.0056	0.006	Commercial Services
R1R	0.003	758	0.0012	41.18%	0.0021	0.0021	Restricted Residential
R1	0.003	1388	0.0021	70.48%	0.0021	0.0024	Low Density Residential
RMU	0.013				0.0091	0.010	Residential Mixed Use
R3050	0.013	2710	0.0042	32.25%	0.0091	0.008	Moderate Density Residential
R2250	0.013	4861	0.0075	57.88%	0.0091	0.009	Medium Density Residential
R1650	0.013	6187	0.0095	73.64%	0.0091	0.010	Medium High Density Residential
R1250	0.013	8918	0.0138	106.16%	0.0091	0.014	High Density Residential
CG						0.006	Commercial General
CA/CG						0.006	Comml. Auto/Comml. General
CG/MS						0.006	Comml. Genl/Med. Services
CA/CS						0.006	Comml. Auto/Comml. Specialty
CA/O						0.006	Comml. Auto/Office
CN DD						0.006	Comml. Neighborhood-Design Develop.
SFMU						0.01	Comml._Res. Mixed Use
IND						0.006	Industrial
IMU						0.006	Indus./Comml. Mixed Use
IMU R						0.006	Indus./Comml. Res. Mixed Use
For a new entry						0	If no entry, delete row
CCR	0.006				0.0056	0.006	Not on Zoning Map
CMU	0.006				0.0056	0.006	Not on Zoning Map
M2		1571	0.0024		0.0000	0.0024	Not on Zoning Map
CEM						0.0024	Cemetery
SR	0.003				0.0021	0.0024	Special Recreation
T						0.006	Transportation
Alex Theater	0.015		0.006		0.0106	0.011	
Civic Areas	0.02		0.007		0.0140	0.014	
Broadway Central	0.096		0.032		0.0672	0.080	
Downtown Mixed	0.03		0.01		0.0210	0.026	
East Broadway	0.025		0.008		0.0175	0.018	
Galleria	0.03		0.01		0.0210	0.021	
Gateway	0.126		0.042		0.0882	0.100	
Orange Central	0.061		0.02		0.0427	0.050	
Town Center	0.03		0.01		0.0210	0.026	

Notes:

1. Named Zones are per the Downtown Specific Plan. City Coefficients for these areas are a proration of the old City coefficient of 0.040, adjusted by allowed building height in the current zoning.
2. Percentage adjustment of City coefficients to K-J coefficients is 70% based on average difference of high density residential zone comparison (R1250 thru R3050).
3. All proposed coefficients are proration of City coefficients based on Kennedy-Jenks differences, since old City coefficients are pre 1972, and significant water conservation measures have reduced overall flows.
4. Premise is infiltration is accounted for in coefficients, and additionally with reduction of peak sewer flow depth reduction to 0.67 from 0.75.
5. Town Center was 0.021 for Colorado SS calc, adjusted for standard based on K-J Town Center flow calc (see below). Colorado SS was adjusted - no sizing impact.

	Alley Slope	gpd/ac	cfs/ac			
Town Center per K-J	0.013	16718.6416	0.0259			

TABLE SS-2

TYBURN SEWER TRUNK LINE CAPACITY IMPROVEMENT

SANITARY SEWER PROJECTED FLOW CALCULATION			Glendale Ave. (East Ln)				Glendale Ave. (East Ln)				Glendale Ave.				San Fernando Rd.			
			[illegible]				[illegible]				[illegible]				[illegible]			
*Kennedy Jenks Coef from 1997 Master Plan of City [illegible] of 3.043 prorated per K-J & interpolated for zones building height. Peak Factor per K-J 1997 Equation			Kennedy Jenks Line [illegible]				Kennedy Jenks Line [illegible]				Kennedy Jenks Line [illegible]				Kennedy Jenks Line [illegible]			
			Outfall @ MH 020196 to 030238				Outfall @ MH 030349 to 010024				Outfall @ MH 010334 to 010347				Outfall @ MH 010331 to MH 010336			
			[illegible]				[illegible]				[illegible]				[illegible]			
Zone	Coefficient, cfs/Acre		(Ac)	Area, (Ac)	(cfs)	(cfs)	Area (Ac)	Area, (Ac)	(cfs)	(cfs)	Area (Ac)	Area, (Ac)	(cfs)	(cfs)	Area (Ac)	Area, (Ac)	(cfs)	(cfs)
C1	0.030	Neighborhood Commercial	3.001	3.001	0.021	0.021	0.000	3.581	0.000	0.021	0.000	3.581	0.000	0.021	0.000	3.581	0.000	0.024
C2	0.030	Community Commercial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C3	0.030	Commercial Services	1.424	1.424	0.010	0.010	4.706	6.279	0.020	0.038	0.000	6.279	0.000	0.038	0.000	6.279	0.000	0.038
[illegible]	0.0077	Restricted Residential	19.648	19.648	0.020	0.020	10.863	29.521	0.022	0.062	0.000	29.521	0.000	0.062	0.000	29.521	0.000	0.062
R1	0.0024	Low Density Residential	0.867	0.867	0.002	0.002	0.000	0.867	0.000	0.002	0.000	0.867	0.000	0.002	0.000	0.867	0.000	0.002
RMU	[illegible]	Residential Mixed Use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R3050	0.008	Moderate Density Residential	3.758	3.758	0.030	0.030	2.664	6.480	0.021	0.051	0.000	6.480	0.000	0.051	0.000	6.480	0.000	0.051
R2250	0.030	Medium Density Residential	26.460	26.460	0.184	0.184	0.000	26.460	0.000	0.184	0.000	26.460	0.000	0.184	0.000	26.460	0.000	0.184
R1650	[illegible]	Medium High Density Residential	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R1250	0.014	High Density Residential	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CC	0.030	Commercial Center	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.065
[illegible]	0.030	Comm'l Auto/Comm'l General	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	[illegible]	[illegible]	0.000	0.027
[illegible]	0.030	Comm'l General/Mfr Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.543	2.543	0.000	0.021
[illegible]	0.030	Comm'l Auto/Comm'l Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	0.030	Comm'l Auto/Office	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	0.030	Comm'l Neighborhood Design District	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	[illegible]	Comm'l/Ind. Mixed Use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.040	1.040	0.000	[illegible]
IND	0.030	Industrial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IMU	[illegible]	Industry/Comm'l Mixed Use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	0.030	Industry/Comm'l Res Mixed Use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	0	[illegible]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DSR	0.030	Future Zoning Map	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	0.030	Future Zoning Map	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
[illegible]	[illegible]	Future Zoning Map	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CEM	0.0024	Cemetery	10.817	10.817	0.026	0.026	0.000	10.817	0.000	0.026	0.000	10.817	0.000	0.026	0.000	10.817	0.000	0.026
SR	0.0024	Special Recreation	2.000	2.000	0.005	0.005	0.000	2.000	0.000	0.005	0.000	2.000	0.000	0.005	0.000	2.000	0.000	0.005
T	[illegible]	Transportation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eq (1)		Q ave (cfs)			0.247	0.247				0.379				0.404				0.552
Eq (2)		Peak Factor (PF), Q is in mgd		2.05				2.01				2.34				1.96		
Eq (3)		Q Peak				0.507				0.762				0.940				1.027
Slope				0.0050				0.0040				0.0040				0.0046		
Manning's Coefficient, n				0.013				0.013				0.013				0.013		

Pipe Sizing based on Q Average

(for D/d=0.5 (pipes 15" & under), k=0.232; for D/d=0.67 (pipes 18" & larger), k=0.2404)

Max. Dep./Depth (d/D)	0.5							
K' factor	0.232							
Eq. (4) d=[Qn/K'S^0.5]^3/8		Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
Based d (diameter) Required for Q Avg		0.698	7.600	0.646	7.747	0.364	4.371	0.480	5.776
Existing Sewer Pipe Size			8		8		8		8
Proposed Sewer Pipe Size			8		8		10		15

Pipe Sizing based on Q Peak

		for D/d=0.5, k=0.232		for D/d=0.5, k=0.232		for D/d=0.5, k=0.232		for D/d=0.5, k=0.232	
Max. Dep./Depth (d/D)	0.5								
K' factor	0.232								
Eq. (4) d=[Qn/K'S^0.5]^3/8		Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
Based d (diameter) Required for Q Peak		0.779	9.351	0.887	10.636	0.463	5.559	0.591	7.094
Existing Sewer Pipe Size			8		8		8		8
Proposed Sewer Pipe Size			10		10		12		12

Qact (Qave) Analysis

	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
	Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe	
Diameter	0.67	8	0.83	10	0.67	8	0.83	10	0.67	8	0.83	10	0.67	8	1.00	12
Radius	0.33	4	0.42	5	0.33	4	0.42	5	0.33	4	0.42	5	0.33	4	0.50	6
d, Actual Flow Depth for Qave**	0.28	3.31	0.25	3.02	0.32	3.81	0.29	3.44	0.34	4.12	0.31	3.68	0.19	2.33	0.17	2.04
Angle of Cross section Area	2.796		2.307		3.061		2.581		3.282		2.871		2.396		1.730	
Pipe Cross section Area, A	0.128		0.139		0.162		0.185		0.181		0.192		0.085		0.089	
Wetted Perimeter, P	0.932		0.979		1.025		1.085		1.092		1.063		0.798		0.850	
Hydraulic Radius, R	0.146		0.142		0.157		0.159		0.179		0.180		0.111		0.104	
Qact Check		0.41		0.33		0.40		0.34		0.52		0.37		0.29		0.17

File: [illegible]

TABLE SS-2

TYBURN SEWER TRUNK LINE CAPACITY IMPROVEMENT

SANITARY SEWER PROJECTED FLOW CALCULATION		Glendale Ave. (East Ln)				Glendale Ave. (East Ln)				Glendale Ave.				San Fernando Rd.			
		[illegible]				[illegible]				[illegible]				[illegible]			
Kennedy-Jenks Coefficient from 1997 Master Plan of City [illegible] of 0.0[illegible] prorated per K-J, & interpolated for zoned building		Kennedy Jenks Line 7648				Kennedy Jenks Line 7731				Kennedy Jenks Line 7825				Kennedy Jenks Line 7827			
Eq (1)	Qave Check	0.377		0.378		0.391		0.392		0.422		0.425		0.471		0.359	
Velocity (fps) for Q Avg		2.304		2.2[illegible]		2.306		2.280		2.321		2.215		6.156		[illegible]	
Q peak Analysis		Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
		Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe		Existing Pipe		Proposed Pipe	
Diameter		0.67	8	1.00	12	0.67	8	1.00	12	0.67	8	1.25	15	0.67	8	1.00	12
Radius		0.33	4	0.50	6	0.33	4	0.50	6	0.33	4	0.63	7.5	0.33	4	0.50	6
d, Actual Flow Depth for Q peak**		0.43	5.1	0.34	4.05	0.50	6.05	0.38	4.6	0.50	5.98	0.38	4.5	0.28	3.30	0.23	2.78
Angle of Cross Section Area		3.689		2.498		4.219		2.4[illegible]		4.420		2.310		2.386		2.013	
Pipe Cross section Area, A		0.275		0.275		0.285		0.277		0.293		0.313		0.127		0.129	
Wetted Perimeter, p		1.230		1.248		1.400		1.335		1.506		1.449		0.935		1.006	
Hydraulic Radius, R		0.150		0.189		0.20[illegible]		0.208		0.201		0.214		0.147		0.129	
d/D Check			0.64		0.34		0.76		0.38		0.87		0.30		0.42		0.23
Eq (3)	Q peak Check	0.659		0.660		0.762		0.761		0.842		0.841		1.626		0.504	
Velocity (fps) for Q peak		2.779		2.797		2.7[illegible]		3.0[illegible]		2.9[illegible]		2.797		7.428		7.192	
Final Design Pipe Size		12				12				15				12			
Kennedy Jenks Proposed Pipe Size (Ultimate)		Ln 7648	ADWF	PDWF	PWWF	Ln 7731	ADWF	PDWF	PWWF	Ln 7825	ADWF	PDWF	PWWF	Ln 7827	ADWF	PDWF	PWWF
			10	12	12		10	12	12		10	12	15	10	10	12	15
														Recently Upgraded-See Cerritos Project			

Eq (2) Peak Factor (PF)=-0.0[illegible]ln(Qave)+1.70; (Q in MGD) Kennedy-Jenks Equation

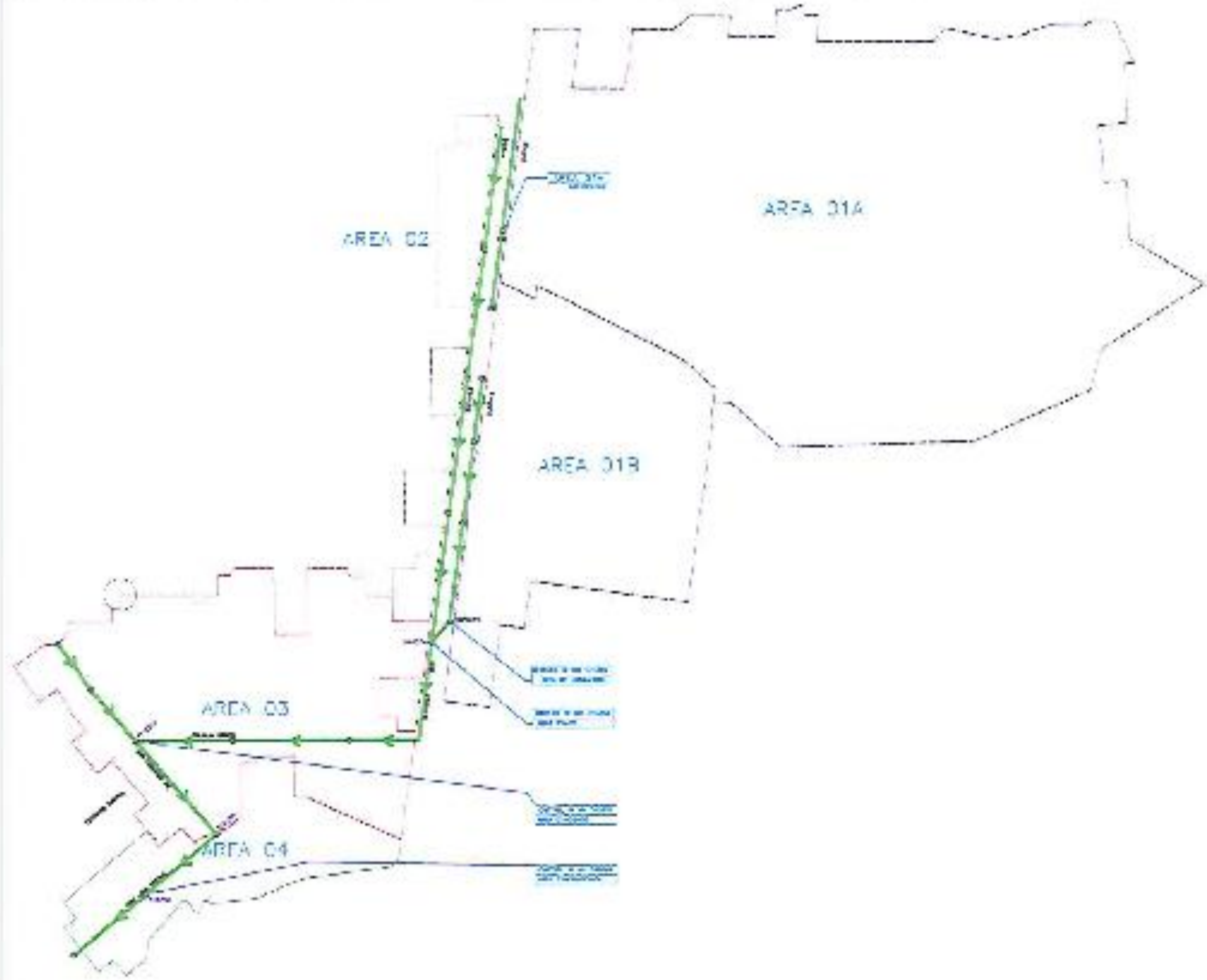
Eq (3) Qpeak=(PF) x Qave

Eq (4) $Q=(k')(d^{8/3})(S_f^{1/2})/n$

k'=hydraulic factors for circular conduits flowing partially full

** This is a Trial Method: Enter Actual Flow Depth (D) until Qave is same as Qave in Eq (1)

TYBURN SEWER TRUNK LINE CAPACITY IMPROVEMENT



GRAVITY SEWER DESIGN COMPUTATION SHEET

Date ______________________

Project ______________________

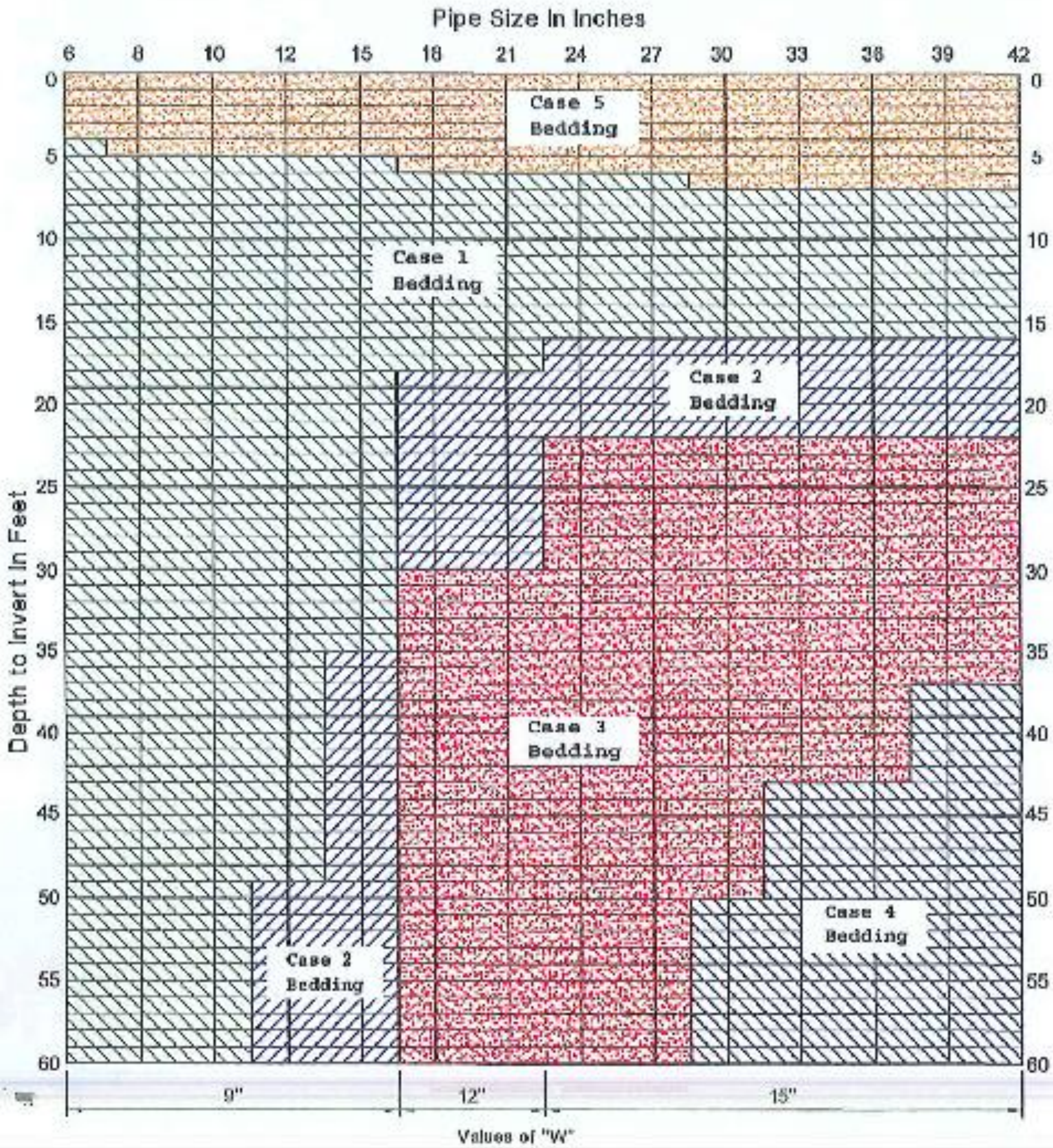
MH			Flow		Sewer								MH	
No	Station		ADWF (a)	PDWF (b)	Length	Slope	Pipe Dia. (c)	Velocity (d)		Fall	dc (e)	dn (f)	Flow-Line Elevations	
	From	To	(cfs)	(cfs)	(ft)	(ft/ft)	(in)	ADWF (fps)	PDWF (fps)	(ft)	(ft)	(ft)	In	Out

a. ADWF = Average Dry Weather Flow
b. PDWF = Peak Dry Weather Flow
c. Pipe size based on d/D = 0.5 at PDWF
d. Minimum velocity of ~~3~~ fps required (based on PDWF) 2
e. dc = Critical Depth
f. dn = Normal depth

Figure F256

APPENDIX B

Plans

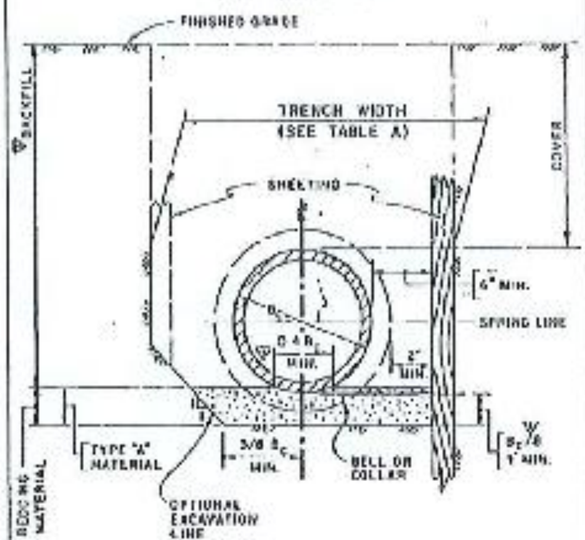


See Table "A" On Standard Plan Titled "Pipe Laying in Trenches"

Bedding Requirements for Clay Pipe In Trenches
Figure F490.1

CASE 1 BEDDING INSTALLATION

LOAD FACTOR = 1.4

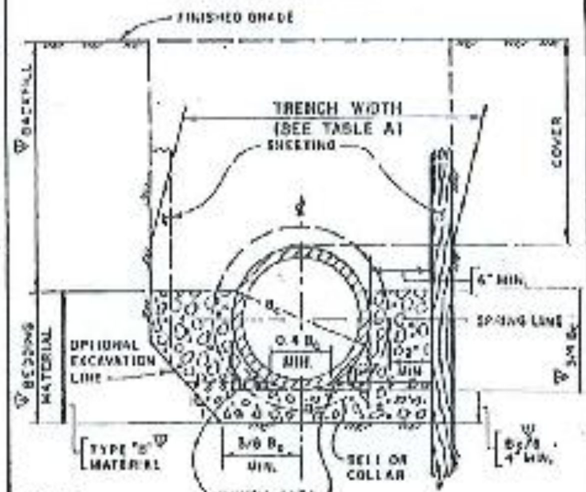


NOTE:

(symbol) INDICATES UNDISTURBED EARTH

CASE 2 BEDDING INSTALLATION

LOAD FACTOR = 1.9



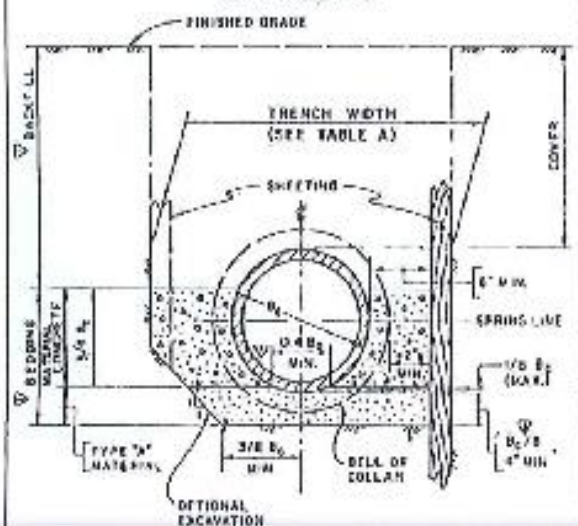
NOTES:

A. (symbol) INDICATES UNDISTURBED EARTH

B. TYPE "B" MATERIAL SHALL BE PLACED IN A MANNER SUCH AS SLICING, SHOVEL-SPADING, OR SHOVEL RODDING TO INSURE COMPLETE FILLING OF THE 'HAUNCH AREAS' BELOW THE PIPE. (JETTING OF TYPE "B" MATERIAL IS NOT REQUIRED).

CASE 3 BEDDING INSTALLATION

LOAD FACTOR = 2.7



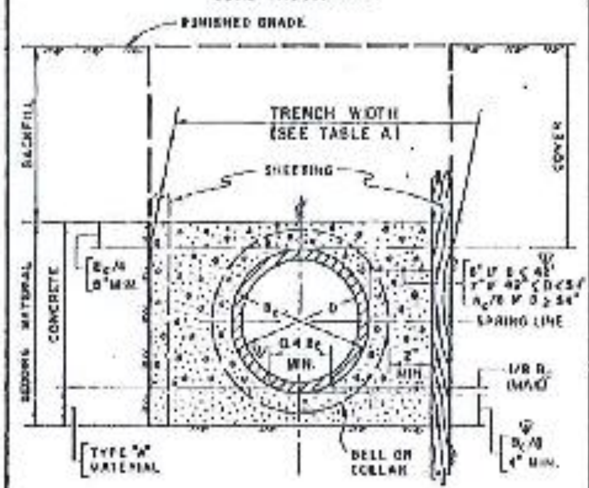
NOTES:

A. (symbol) INDICATES UNDISTURBED EARTH

B. SEE NOTE 5.

CASE 4 BEDDING INSTALLATION

LOAD FACTOR = 3.8



NOTES:

A. (symbol) INDICATES UNDISTURBED EARTH.

B. < INDICATES "LESS THAN"; ≤ INDICATES "LESS THAN OR EQUAL TO"; ≥ INDICATES "GREATER THAN OR EQUAL TO".

DEPARTMENT OF PUBLIC WORKS

BUREAU OF ENGINEERING — CITY OF LOS ANGELES

PIPE LAYING IN TRENCHES

STANDARD PLAN S-251-1

SUBMITTED Dec. 26, 1973

APPROVED January 2, 1974

REVISIONS				
NO	DATE	DESCRIPTION		
1	2-7-77			

SUPERSEDES: S-308

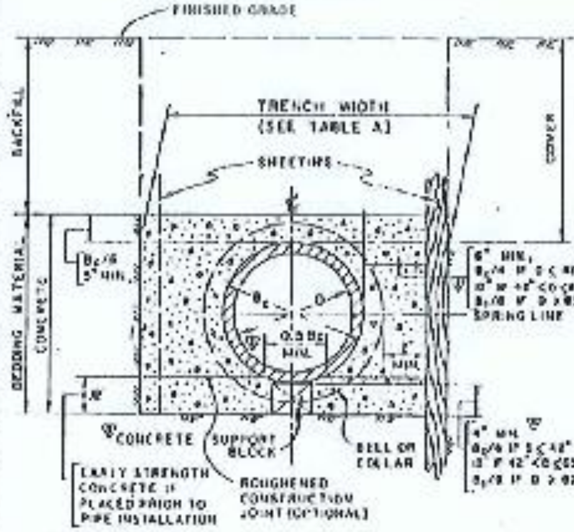
REFERENCES

VAULT INDEX NUMBER S-2393

SHEET 1 OF 2 SHEETS

CASE 5 BEDDING INSTALLATION

LOAD FACTOR = 4.5



NOTES:

A. [illegible] INDICATES UNDISTURBED EARTH.

B. TREATED PINE SHIMS MAY BE USED FOR GRADE ADJUSTMENT.

C. < INDICATES "LESS THAN"; ≤ INDICATES "LESS THAN OR EQUAL TO", > INDICATES "GREATER THAN".

D. Ψ INDICATES AREA REFERRED TO IN NOTE 12.D.(2).

TABLE A

MAXIMUM ALLOWABLE TRENCH WIDTH

NOTES: [illegible]

INSIDE DIAMETER	PLASTIC, CLAY & CAST IRON	RCP WITH BELLS OR COLLARS	ACP & RCP WITHOUT BELLS OR COLLARS
8" - 18"	B_c + 18"	B_c + 32"	B_c + 26"
19" - 21"	B_c + 24"		
22" - 42"	B_c + 36"		
43" - 96"	------		
OVER 96"	......	B_c + 32"	B_c + 44"

TABLE B

SUBSTITUTE INSTALLATIONS (APPLICABLE TO ALL PIPE SIZES)

NOTES A. SEE NOTE 2.

B. CASE - INSTALLATION CASE SPECIFIED ON THE PLANS

C. COVER - IF COVER EXCEEDS 30 FEET, SUBSTITUTE SHALL BE AS ORDERED BY THE ENGINEER

D. SPECIAL - CONTRACTOR SHALL CONSTRUCT SPECIAL AS DESIGNED BY THE ENGINEER.

GENERAL NOTES

1. [illegible]

Ψ 2. [illegible]

3. [illegible]

Ψ 4. [illegible]

5. [illegible]

Ψ 6. [illegible]

7. [illegible]

8. [illegible]

9. [illegible]

Ψ 10. [illegible]

11. BEDDING

A. [illegible]

B. [illegible]

C. [illegible]

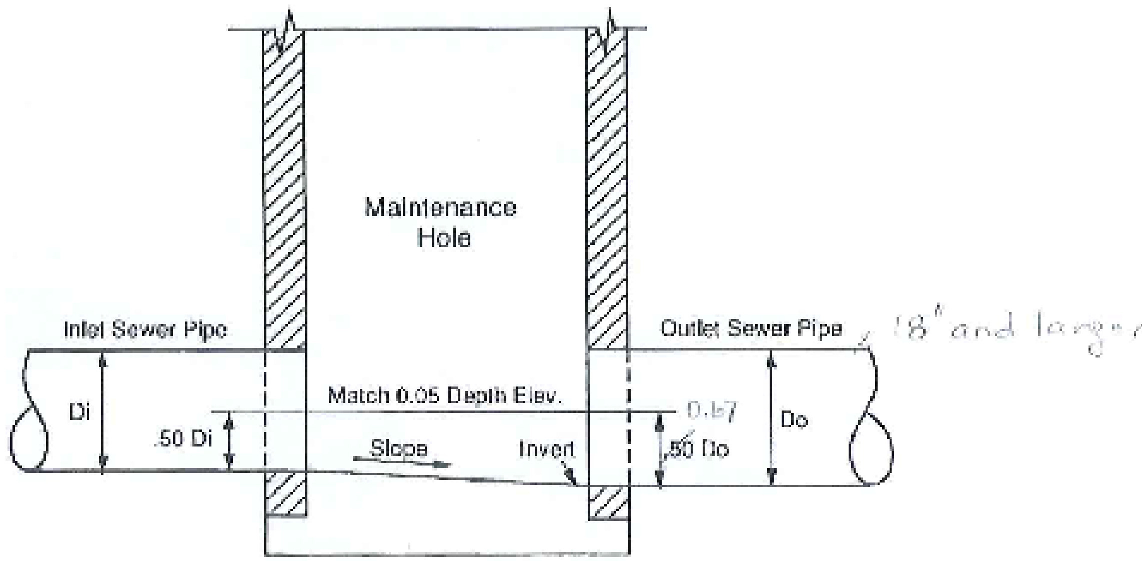
Ψ 12. BACKFILLING: [illegible]

[illegible]

STANDARD PLAN NO. S-251-1

[illegible] B-3893

SHEET 2 OF 2 SHEETS



Invert Drop across Maintenance Holes
Pipe Sizes 18-inches and Greater
Figure F255

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