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F 400 SEWER MATERIALS AND STRUCTURES

The City's existing wastewater collection system consists primarily of vitrified clay pipe (VCP) and reinforced concrete pipe (RCP) with plastic liner plate. There are some unlined concrete pipes, plastic pipes, brick arches, clay tile-lined reinforced concrete pipe and reinforced concrete boxes and arches. Existing structures are primarily brick with cement mortar or reinforced concrete lined with plastic liner plate. Standard Plans showing sewer structures and appurtenances are contained at the end of this Section for reference.

F 410 SEWER PIPE

Sewer pipe materials and construction methods are specified in detail in the SSPWC and the Brownbook. The Structural Engineer shall check sewer pipe strength requirements. All sewer pipes shall be installed in accordance with the project plans and specifications. All pipe sizes refer to the nominal inside diameter of pipe.

F 411 VITRIFIED CLAY PIPE

VCP sewer pipe may be specified in sizes 6 inch through 42 inch. Except as modified by the SSPWC and the Brownbook, VCP and fittings shall be extra strength manufactured in accordance with ASTM C 700.

F 412 REINFORCED CONCRETE PIPE

RCP shall be used for sewers larger than 42 inch. Except as modified by the SSPWC and Brownbook, RCP shall be manufactured in accordance with ASTM C 76. Plastic liner plate circumferential requirements shall be determined and shown on the plans. Plastic liners shall be Polyvinyl Chloride (PVC) conforming to the SSPWC, Brownbook, and Standard Plan S-121. The liner plate shall extend a minimum of 2 inches below the hydraulic grade line at minimum flow. Minimum strength of RCP with or without bells for Bedding Case I, II, and III shall be in accordance with Figures F490.2.C1, F490.2.C2, F490.2.C3, F490.2.C1B, F490.2.C2B, and F490.2.C3B.

F 413 CONCRETE PIPE

Unreinforced concrete pipe is not permitted for use in City sewers.

F 414 ASBESTOS CEMENT PIPE (ACP)

ACP is not permitted for use in City sewers.

F 415 PLASTIC PIPE

Because of the rapidly changing nature of sewer pipe materials, this subsection is subject to modification. In general, plastic pipe is permitted on any sewer as long as it is on the Engineer of Design's Approval Pipe and Pipe Product Suppliers List.

The use of plastic pipe is governed by the following criteria:

a. Plastic Pipes can be bid as an alternate to VCP or RCP.

b. Plastic pipes shall not be permitted where concentrated discharges of industrial or commercial sewage exist. Where this cannot be avoided the sewer shall not be permitted to be constructed of plastic materials.

c. Plastic pipe may be used when abrasive action in the sewer is not anticipated. Flow velocities and the amount and types of solids generated shall be considered to determine abrasive action. Generally, velocities should not exceed 12 fps.

d. Plastic pipe sewers shall be limited in size to:

    1. Main Line: 8 inch to 15 inch
    2. House Connections: 6 inch minimum.

e. The maximum design deflection (flattening) for plastic pipe shall be 3 percent for PVC Composite Pipe and 5 percent for Solid Wall PVC and ABS pipe. To assure that solid wall plastic pipe has sufficient stiffness, the minimum wall thickness SDR (standard dimension ratio of pipe outside diameter to pipe wall thickness) shall be 35 for PVC.

f. Since concrete will not bond to most plastics, some form of seal or water stop is required to provide a watertight maintenance hole connection. A maintenance hole coupling, can be cast directly into the maintenance hole or base or grouted into precast concrete maintenance holes. As an alternative, a rubber adaptor ring can be placed around the pipe stub to be cast into the maintenance hole wall

g. Unless specified, the design criteria shall be the same as currently used for clay pipe sewers.

Prior to the preparation of any sewer plan, the Engineer shall investigate and determine if plastic pipe is suitable for the project as an alternate pipe material. If plastic sewer pipe is acceptable, the plans shall call for "Sewer Pipe". If plastic sewer pipe is unacceptable for the project, the plans shall call for "VCP" or "RCP".

F 415.1 COMPOSITE PIPE (TRUSS PIPE)

Composite pipe is a plastic pipe consisting of two concentric tubes with a "truss" connecting the two concentric tubes. The pipe between the concentric tubes is filled with cementitious slurry or inert materials. The plastic tubes shall be Acrylonitrile-Butadiene-Styrene (ABS). The requirements for this pipe are set forth in ASTM D2680 and modified by the SSPWC and Brownbook. This pipe may be used for main line and HC sewers.

F 415.2 ABS SOLID WALL PIPE

ABS pipe maybe used for both main line and HC sewers. Requirements are set forth in the SSPWC and Brownbook.

F 415.3 PVC SOLID WALL PIPE

PVC pipe may be used for both main line and HC sewers provided the following requirements are met:

a. Only pipe conforming to ASTM D3034 is approved.

b. Minimum wall thickness shall conform to Standard Dimension Ratio (SDR) 35.

c. Fillers in the resin shall not exceed 10 parts per 100 parts of resin by weight, of the PVC resin (See SSPWC).

d. All requirements set forth in the SSPWC and Brownbook are met.

F 415.4 PE SOLID WALL PIPE

PE Pipe may be used for both main line and HC sewers provided the following requirements are met:

A. Only pipe conforming to ASTM D 3350 is approved.
B. Minimum wall thickness shall conform to Standard Dimension Ratio (SDR) 21.
C. Pipe and fitting shall be made from PE resing complying with ASTM D 1248.
D. All requirements set forth in SSPWC and Brownbook are met.

F 415.5 CCFRPM PIPE

CCFRPM Pipe may be used for main line sewers provided the pipe confirms to ASTM D 3262 and all requirements set forth in SSPWC and Brownbook are met.

F 415.6 DIRECT BURIAL PROFILED WOUND PE

Direct Burial Profiled Wound PE pipe may be used for main line sewers provided the product is on the Engineer of Design's Approval Pipe and Pipe Product Supplier's List.

F 415.7 DIRECT BURIAL CLOSED PROFILE WOUND PE

Direct burial Closed Profile Wound PE pipe may be used for main line sewers provided the product is on the Engineer of Design's Approved Pipe and Pipe Product Supplier's List.

F 415.8 OTHER PLASTIC PIPES

The Engineer of Design continues to review and investigate plastic pipes for use as main line sewers. Any pipe listed on the updated Engineer of Design's Approved Pipe and Pipe Product Supplier's List may be used.

F 416 CORRUGATED STEEL PIPE

Corrugated steel pipe (CSP), also known as corrugated metal pipe shall not be used for sewer pipe except for temporary and emergency situations such as bypassing sewage around current construction work. Since the CSP roughness factor (n) will significantly differ from the existing sewer pipe and air line roughness factors, any design shall be checked thoroughly to ensure adequate flow capacity and continuity during construction. See Manual Part G for additional information.

F 417 DUCTILE IRON PIPE

Ductile iron pipe (DIP) is superior in strength, resistance to electrolytic corrosion, and it is considered sparkproof. These qualities shall be considered when high strength sewer pipe or pressure pipe is required. DIP is primarily used for force mains but may be used for gravity sewers when warranted.

F 420 REINFORCED CONCRETE BOX

Generally, reinforced concrete box (RCB) should not be specified for large sewers since lined RCP is available in sizes up to 108 inch diameter. Larger sizes are available on special order. RCB sewer is usually required in treatment plant sewage conveyance systems. RCB sections are used in sewage diversion systems and in reaches having limited vertical or horizontal alignment. Precast RCB sections are available.

F 421 RCB ECONOMIC COMPARISON

The RCB becomes economically competitive with RCP at about 84 inch diameter for unlined sewers; however, the City prefers the circular hydraulic section, which, because of its geometric shape provides higher minimum velocities at low flows. A cost study should be made to determine which conduit is more economical. Plastic plate lining construction for either pipe or box is expensive and requires critical fabrication control that is best provided in a fabrication plant as opposed to a field construction site. The Engineer should check current construction costs with the Construction Management Division, Estimating Group, prior to specifying an RCB. Other considerations should include traffic safety, convenience and the construction period involved. When warranted, the Engineer may provide for both, RCP and RCB, as bid alternates on the same project. RCB shall be lined with PVC Plastic liner in the same fashion as RCP. (See F 412).

F 422 RCB DESIGN RESPONSIBILITIES

If necessary and economically feasible the Engineer shall determine the RCP hydraulically equivalent RCB. Part G of the Manual may be referred to for guidance in RCB size equivalence to RCP. The Engineer shall consider air line capacity in a sewer. Therefore, the RCB shall be designed as an open rectangular channel. Unlike RCP, the RCB will require detailed structural designs by the SED. Plastic liner-plate details are shown on Standard Plan S-121.

F 430 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.

F 431 JOINTS LISTED IN SSPWC

The SSPWC covers joints for pipes described in F 410. The "Brown Book", Additions and Amendments to the SSPWC, specifies any restrictions contrary to SSPWC for City projects.

F 431.1 JOINTS FOR VCP PER SSPWC

The City allows four joints; Types D, G and Z covered in the SSPWC and the project plans.

F 431.11 TYPE D JOINT

Type D shall be used for 6" plain end VCP with maximum deflection less than 2 ½ degree. (Reference: Brownbook, 306-1.2.3)

F 431.12 TYPE G JOINT

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

F 431.13 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.

F 431.14 TYPE C JOINT

Type C was deleted from the SSPWC. See project plans. This joint may be used to join VCP larger than 12 inch in size.

F 432 RCP JOINT

The Engineer shall specify a bell and spigot rubber gasketed joint which conforms to ASTM C 443 for waterproof, gasproof and rootproof lined RCP sewers. The joints shall be designed to be self-centering.

F 433 JOINTS IN REINFORCED CONCRETE STRUCTURES

If the Standard Plans or the SSPWC do not adequately specify the joints to be used in reinforced concrete structures, such as, RCB, the details must be shown on the structural plans or specified in the project specifications.

F 440 SEWER MAINTENANCE HOLES

Sewer Maintenance Holes (MH) are shown in the Standard Plan series. Unless otherwise specified, Standard Plan S-140 details basic requirements for all sewer MHs. If the Standard Plans do not provide the criteria necessary for a MH in question, special details will be required on the plans and in the project specifications.

F 441 SEWER MAINTENANCE HOLE APPURTENANCES

Sewer MHs shall be equipped with appurtenant elements to enhance operation and maintenance as well as safety.

F 441.1 SEWER MAINTENANCE HOLE STEPS

The City of Los Angeles no longer installs MH steps except in special situations. Access is by the use of a nonferrous ladder or a cage lowered into the shaft.

Projects requiring modification of a sewer MH or the raising or lowering of the maintenance hole frame and cover require the existing steps to be removed neatly.

F 441.2 SEWER MAINTENANCE HOLE FRAME AND COVER

A minimum size 27 inch maintenance hole frame and cover (MHF&C) shall be installed on every new sewer MH. See Standard Plan S-282. The size (MHF&C) shall vary with the maximum pipe size connected to the MH as indicated in Standard Plan S-140. (See Table F 462.)

A 36 inch MHF&C as shown in Standard Plan S-286 may be used to provide a large access cover when necessary for maintenance (e.g. very shallow MHs). The Bureau of Sanitation shall be consulted on the intended use of this size cover.

Pressure MHF&C Standard Plan S-284 shall be required when the hydraulic grade line of the sewer may rise to within 1 foot of the top of the maintenance hole. This MHF&C shall be fitted with a pressure maintenance hole collar as shown in Standard Plan S-285.

Certain MHs in the City are designated for use as discharge sites for disposing sewage collected during sewer repairs and from the cleaning and pumping of septic tanks. These MHs shall be fitted with a MH cover which has a removable 5 inch diameter "Inspection Cover" as shown in Standard Plan S-151. The installation and location of this type of cover require the concurrence of the Bureau of Sanitation.

F 441.3 SEWER MAINTENANCE HOLE INNER COVERS

MH inner covers as shown in Standard Plan S-155 or S-156 may be installed when sewer gases can escape into the atmosphere or to reduce inflow when subject to flooding. These covers may also be used to prevent surface water inflow.

F 441.4 SEWER MAINTENANCE HOLE DISC

Sewer MH Discs Standard Plan S-157 may be installed on sewer MHF&Cs to prevent dirt and rubbish from falling through the MHF&C.

F 441.5 OTHER APPURTENANCES

Other appurtenances may be required in special conditions. Some are required for special structures. See the sections/subsections pertaining to those special structures. Other hardware may be specially designed and shown on the plans for a particular project.

F 441.6 OUTDATED APPURTENANCES

The City of Los Angeles no longer installs Flush Tanks. Projects rehabilitating sewers should remove flush tank mechanism from adjacent MH and remodel the MH base if necessary to provide maintenance access.

F 442 BRICK MAINTENANCE HOLE

Brick MHs as shown in Standard Plan S-141 may be specified as the standard sewer MH. The City

of Los Angeles now uses lined or coated precast concrete MHs readily available from local makers.

F 443 PRECAST CONCRETE MAINTENANCE HOLE AND COATINGS

The precast concrete MH as shown in Standard Plan S-142 should be used. These 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. Coatings are tested at the Department of General Services Standards Laboratory. Coatings that pass requirements of Subsection 210-2.3.3 may not pass the City Engineer's field application test(s). An approved list of protective coatings for precast concrete MHs is maintained by the Bureau's Pipe Standards Investigation Group and is available on Bureau's Web Site.

F 444 CLAY PIPE MAINTENANCE HOLE

A Clay Pipe MH as shown in Standard Plan S-143 may be allowed on any sewer that does not exceed 18 inch diameter. Where there is a junction within the MH, all shelves shall be a minimum of 12 inches wide. A Clay pipe MH is smaller than the standard MH and should only be used with the Bureau of Sanitation maintenance group's concurrence.

F 445 SHALLOW SEWER MAINTENANCE HOLE

A shallow sewer MH as shown in Standard Plan S-144 shall be used when the sewer is too shallow to install a standard MH. The depth of the MH will be dependent upon the design depth of the pipe.

F 446 WEIR MAINTENANCE HOLE

Weir MHs shall be used to gauge sewer flows. This may occur when the City accepts contract flows from another agency or when, for recordkeeping purposes, the BOE or other Bureaus or Departments require accurate information relative to sewage flows. When flows are low, (1 cfs maximum) a weir MH Type I as shown in Standard Plan S-145 is recommended. When flows are greater than 1 cfs Weir MH Type II as shown in Standard Plan S-146 may be required. Both MHs utilize adjustable weirs for gauging flows. Although not shown in the Standard Plans, automatic recording devices

may be installed as an element of the maintenance hole flow measurement. The Wastewater Conveyance Engineering Division, the Bureau of Sanitation, and the Wastewater Collection Services Division shall be consulted prior to proposing a weir MH to determine its necessity and the type of appurtenances and details required for the gauging site. Weir plates used with these MHs are shown on Standard Plan S-152.

F 447 OFFSET MAINTENANCE HOLE

Offset MHs as shown in Standard Plan S-147 can be used to avoid curb and gutter, and railroad tracks among others. The use of offset MHs should be avoided. Because the offset breaks the line of sight, it creates an unsafe condition for confined space entry.

F 448 DROP SEWER MAINTENANCE HOLE

Drop sewer MHs as shown in Standard Plan S-148 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. Drop sewer MHs are often used in hillside areas where there are frequent changes in grade and elevation. Inlet sewer size into the drop sewer MH shall be limited to 12 inches.

F 449 TRAP SEWER MAINTENANCE HOLE

Trap sewer MHs are used to prevent sewer gases from flowing upstream in the sewer line. There are two types of trap structures.

F 449.1 TRAP MAINTENANCE HOLE

A trap MH as shown in Standard Plan S-139 shall be placed on a sewer at a location where there is no junction to prevent sewer gases from flowing back up into the system. For example, this structure may be used where a small diameter sewer discharges into a large outfall sewer. Sewage gases are prevented from backing upstream under pressure into the smaller lateral.

F 449.2 JUNCTION TRAP MAINTENANCE HOLE

A junction trap MH as shown in Standard Plan S-149 shall be used where there is a junction. This structure prevents sewer gases from backing upstream into the lateral.

F 450 CLAY PIPE MAINTENANCE HOLE SHAFT

The clay pipe MH shaft as shown in Standard Plan S-128 shall be used for large sewers, such as, RCB, RC Arch, or RCP. The clay pipe shaft is placed directly upon the sewer. The SED shall review such proposals for structural adequacy.

F 451 SPECIAL SEWER MAINTENANCE HOLES

Special MHs should be specified only when the standard MHs cannot be used or modified for the particular problem or application. The District/Division Engineer shall review the need for Special MHs.

F 452 TERMINAL CLEANOUT STRUCTURE "Y"

The terminal cleanout structure "Y" (TCS-Y) as shown in Standard Plan S-164 shall be used at terminal ends of sewers when no future extension is expected. It also has been utilized in street abandonments in conjunction with freeway construction and similar situations. Its use shall be limited to 200 feet maximum from the nearest downstream MH and to 8 inch sewers.

F 453 EXISTING SEWER MAINTENANCE HOLES

The Engineer may have to prepare plans involving existing sewer structures. Sometimes sewer pipes are stubbed from existing MHs for future connections to avoid renovation of existing structures when extensions are constructed. This situation does not exist in all cases. Some existing MHs may need to be removed or remodeled. With regard to street improvement projects, sewer reconstruction and adjustment of sewer MHs to new elevations may be necessary. Standard Plans detail some of the necessary reconstruction techniques for existing sewer MHs.

F 454 REMODELING EXISTING MAINTENANCE HOLES

A sewer MH may be remodeled simply by placing a note on the plan indicating the MH to be remodeled and referring to the applicable Standard Plan for the desired work to be done. A supplemental detail may provide a more precise method of indicating the work to be completed by the contractor. The need for details depends upon each specific situation. If there is sewage flow within the existing sewer MH to be remodeled, see F 471 "Bypass Structures".

F 455 ADJUSTING SEWER MAINTENANCE HOLES TO GRADE

Existing sewer MHs may require adjustment in height. This may result from changes in street grades, settlement of the MH or other reasons. Sewer MH adjustment-to-grade shall conform to Standard Plan S-137. Any 24 inch MHF&Cs in poor condition should be replaced with 27 inch MHF&C sets. Also, any interfering steps should be removed per Standard Plan S-137.

F 460 SPACING, SIZING AND LOCATING MAINTENANCE HOLES

Criteria used for spacing, sizing, and locating MHs are based primarily on convenience and safety considerations in providing operation and maintenance of the sewage facilities.

F 461 MAINTENANCE HOLE SPACING

Table F 461 lists the maximum allowable spacing between MH center lines.

Table F 461

MAINTENANCE HOLE SPACING

Sewer Size (Inch)	Maximum Spacing (Ft.)
8 - 15	400
18 - 30	500
Larger than 30	900

Due to sewer gas release and other factors, it may not be practical to install a MH every 900 ft. or at every curve for an outfall sewer. The Bureau of Sanitation should be consulted for the final location selection.

F 462 MAINTENANCE HOLE SIZES

The MH size is dependent on the largest pipe size connected to the MH. Table F 462 lists the minimum required MH inside diameter with respect to pipe sizes connected to the MH. See also Standard Plan S-140. The Engineer may increase the MH to the next largest size upon his discretion with the approval of the District/Division Engineer.

Table F 462

MAINTENANCE HOLE SIZES

Sewer Size (Inches)	Min. MH Inner Dia.	Size Frame & Cover
8 - 15 inches	4.0 feet	Standard 27-inch
18 - 30 inches	5.0 feet	Standard 36-inch
33 inches and over	6.0 feet	Large 36-inch

A clay pipe maintenance hole having a diameter of 3.5 feet may be used for any sewer not larger than 18 inch and having a 12 inch wide minimum shelf (See F 450). Sewers 36 inch or larger should have a 42 inch clay pipe shaft centered over the sewer center line. See Standard Plan S-143.

F 463 MAINTENANCE HOLE LOCATIONS

MHs shall be spaced to comply with the requirements of F 461 and located to provide safety to maintenance workers, pedestrians and vehicular traffic. Proposed locations should be reviewed with the Bureau of Sanitation.

F 463.1 CURVES

A sewer MH shall be provided on horizontal curves, at both the beginning of curve (BC) and the end of curve (EC). Where the horizontal curve is long, or where the subtended angle is more than 90 degrees, a MH shall be provided at intermediate points along the curve. Location of intermediate MHs along the curve shall be reviewed with the Bureau of Sanitation. A MH shall be provided at the point of reverse curve (PRC) unless the entire curve is short and/or the subtended angle is less than 30 degrees. A MH should be provided at the downstream end of the vertical curve unless the change in grade is less than 10 percent. A MH should be provided at a horizontal angle point unless the angle is less than 10 degrees. A MH should be provided at an abrupt change in vertical

alignment, unless the change in grade is less than 10 percent. The primary determination to be made when considering a MH at a change in direction or horizontal or vertical alignment is the possibility of sedimentation. In general, solids and sediments that are in suspension in the sewage will settle when there is a reduction of velocity. The reduced velocity will typically occur when the vertical grade of the sewer is reduced.

F 463.2 PROHIBITED AND UNDESIRABLE LOCATIONS

Sewer MHs should not be located within, in front of, or immediately adjacent to:

a. Fire Stations.

b. Police Stations.

c. Other emergency facilities.

d. Freeway ramps.

e. Driveways serving commercial, industrial and public facilities.

f. Sidewalks.

g. Pedestrian crosswalks.

h. Street intersections except where the MH serves as a junction structure for two or more sewers.

i. Gutters and other depressions or areas subject to inundation of stormwater.

j. Inaccessible areas.

k. Other locations which would adversely affect the public safety and convenience.

Additionally, MHs should not be located in close proximity to schools, hospitals, churches, public buildings and other facilities where pedestrian and vehicular traffic may be considerable or where children or the elderly may congregate. Locations which have adverse geologic conditions, areas containing undesirable soil conditions and areas known to contain or permeate gases such as soil gas or methane should also be avoided. Consult the Geotechnical Engineering Division to resolve locating MHs in these problem areas.

Not all these conditions can be avoided at all times. When one occurs, MHs shall be located by the Engineer in such locations as sound judgment dictates.

F 470 SPECIAL STRUCTURES

Special structures in sewers shall be reinforced concrete with corrosion proof lining such as plastic liner plate or in some cases Series 300 Stainless Steel armor. Many of these structures have not been detailed on Standard Plans because most of these structures have widely varying sizes, uses, configurations and operating capacities. The Engineer shall use discretion and professional judgment in designing such structures.

F 471 BYPASS STRUCTURES

Bypassing maintains the flow in a sewer affected by construction, repair or maintenance activities. Bypass structures have been used on City sewers of all sizes and configurations. Some plans are simple while others are very complex and detailed. The Engineer shall attempt to allow the contractor optimum use of available equipment to attain the desired result. The Engineer shall establish bypassing requirements in the specifications or on the plans (See General Requirement Section) If a bypass involves large volume flows, the Engineer shall detail a bypassing plan on the

sewer plans. The Engineer shall also show an accurate 24 hour hydrograph for diurnal sewage flow (See F 512.14). The Engineer shall contact the Bureau of Sanitation to arrange for flow measurements. When larger sewage flows are anticipated, it is imperative that annual and seasonal variations be investigated.

Normally, airline capacity is difficult or impossible to provide across a bypassing system. If the absence of an airline could create a serious problem, the Engineer shall consult with the Bureau of Sanitation to determine the intensity of the H2S gas in order to specify a suitable odor control measure during the by-pass operation.

F 472 JUNCTION STRUCTURES

Sewer MH standard plans should suffice for junction structures. Large sewer confluences might require a special junction design. All junctions shall be hydraulically analyzed per F 260. For complex designs, especially those involving supercritical flows, a model study at the HRL may be warranted (See F 176). Reinforced concrete structures shall be designed in the same manner as storm drain junctions except that all exposed concrete shall be lined with plastic liner plate and clay pipe shafts shall be provided on each inlet larger than 33 inch. (See Part G of the Manual and the Standard Plan S-303, Junction Structure "C," for storm drain junctions for dimensional details).

F 473 DIVERSION STRUCTURES

A sewer diversion structure shall be designed whenever the sewage flow needs to be diverted from one sewer to another. Diversions may also be used in conjunction with bypass structures (See F 471). The structure may have rectangular or circular sections which need to be equipped with stop logs or sluice gates, either manual or automatic, to control diversion flows. Recent sewage and water treatment reclamation plant plans have detailed examples of diversion structures. The Engineer shall refer to those plans for information relative to a diversion structure. For complex designs, especially those involving supercritical flows and split flows, a model study at the HRL shall be warranted.

F 474 CORE DRILLING

On occasion, it may be necessary to connect a smaller sewer to an existing interceptor, relief or outfall sewer 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. (See SSPWC under "Connections, Junctions, Branches, and Spurs"). Also, see LAMC Section 64.20 for requirements.

F 475 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 excavation or construction will damage the adjacent sewers. For this reason, all existing sewers lying below and within 18 inches of the proposed excavation shall be protected by a concrete blanket for the full width of the excavation. Standard Plan S-255 shows concrete blankets for pipes. Also, see Standard Plan S-111, "House Connection Remodeling" and Standard Plan S-251, "Pipe Laying in Trenches".

F 476 SUPPORTS FOR SEWER PIPE

Sewer pipes across trenches shall be supported per Standard Plan S-253. Special supports shall be designed by the Structural Engineering Division. If temporary supports are required the Engineer shall require the contractor to submit stamped calculations and construction drawings for the temporary support for the Engineer's review.

F 477 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. Nevertheless, constructing a sewer in a tunnel or in a jacked casing or in a microtunneling or in a directional drilling may be necessary or advisable. Sewers may be constructed in a tunnel or in a jacked casing or in a microtunneling or in a directional drilling for any of the following reasons:

a. Excessive depth, generally, greater than 30 feet.

b. Adverse soil conditions which make tunneling or jacking or microtunneling or directional drilling a desirable alternative.

c. Crossing of surface facilities which may not be disrupted such as freeways or other major highways, railroad rights-of-way and other similar facilities.

d. Major surface or subsurface utility systems which may not be disrupted, such as, MWD water lines, DWP water and power lines, telephone trunk lines, oil transmission lines, gas lines and other similar utilities.

e. Construction in a right-of-way or easement where opening of a trench is impossible, impractical or costly.

f. Crossing of a busy intersection

g. Construction in an area having heavy vehicular and/or pedestrian traffic, such as, the downtown area Century City, Colleges, Exposition Park and other similar areas, including commercial areas.

h. Construction adjacent to critical facilities, such as schools, hospitals, police and fire stations where public safety and convenience require minimizing the use of open trenches.

i. Construction in areas such as parks, where environmental problems may be created.

j. Any other condition where public safety and convenience benefit by tunneling or jacking or microtunneling or directional drilling where open trench construction costs would exceed the cost of a tunnel or a jacked casing or microtunneling or directional drilling.

Even when not required by the contract documents, a contractor has the option to construct a sewer in a tunnel or in a jacked casing or microtunneling or directional drilling provided the contractor secures prior approval from the Engineer.

Standard Plan S-254 shows tunnel and jacked casing details. 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.

F 477.1 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. Geologic and soil conditions will be furnished to the Engineer upon request by the Geotechnical Engineering Division. Data to be submitted includes, but is not limited to:

a. Plans and Specifications
b. Geologic Report
c. Test hole and soil analysis log along the tunnel alignment
d. 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:

a. Nongassy
b. Potentially gassy
c. Gassy
d. Extra hazardous

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

F 477.11 FIELD TESTS AND SAMPLING

The Engineer shall submit the following data with the request for analysis to the Geotechnical Engineering Division:

a. Plan and profile of the proposed tunnel or jacked casing with all known utility locations

b. Proposed Specifications

c. Proposed details

F 477.12 CLASS "B" PERMIT PROJECTS

On Class "B" Permit projects, the permittee's engineer shall be responsible for the submittal to CalOSHA and shall submit a copy to the City Engineer. Prior to submittal of the final plans to the Engineer for approval, the plans shall incorporate any special requirements established by the CalOSHA and the tunnel gas classification. To ensure proper processing, the Engineer shall advise the permittee or its engineer of CalOSHA's requirements.

F 477.2 SURVEY SHAFTS

Survey shafts shall be provided to ensure the tunnel is constructed to true alignment. The Engineer shall transmit to the Survey Division two sets of plans and profiles of the tunnel with the request to establish locations for survey shafts. The locations selected shall be shown on the plans as part of the work. (See J 660 of the Bureau Manual).

F 478 SEWAGE GAUGING

The old Parshall flume was designed for free flow conditions, so the water is forced to pass through critical depth within the structure which determines the rate of flow.

The Bureau now uses newer flow devices. The accuracy of the Parshall flume sufficed as a measuring device, however, the new devices are more convient and accurate. Sewage gauging shall be requested through BOS-WCSD. Information relative to the types and advantages of the current flow measurement devices may be obtained from the Wastewater System Engineering Division.

F 480 HOUSE CONNECTIONS

House Connections (HC) conveys sewage from the property line to the main line sewer. HCs serve residential, commercial and industrial facilities. The segment of a HC located within the public way (streets, etc.), or in an easement or right-of-way is under the jurisdiction of the Department of Public Works. The segment located on private property is under the jurisdiction of the Department of Building and Safety (DBS).

When not constructed as part of a project, HCs are installed under a permit in conformance with LAMC, Article 4, Chapter VI, Section 64.12, et seq. An application for the permit, together with the required fees and such plans, profiles, specifications and supporting calculations and details as may be required to review the application shall be submitted to the appropriate district office. (See F 181.)

The minimum size of an HC shall be 6 inch. 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. Each district office maintains "As-Built" HC data on the Sewer Wye Maps.

F 481 TYPES OF SEWER HOUSE CONNECTIONS

Standard Plan S-110 shows the four standard types of HCs. Unless otherwise indicated on the plans or specifications, the Standard Plan requires a Type "A" HC. The Standard Plan also establishes other material and construction requirements for HCs within the public way. The permittee should be referred to DBS for requirements beyond the limits of the public way. (Usually at the property line, i.e. the back of the sidewalk).

F 481.1 ASSESSMENT ACT HOUSE CONNECTIONS

Each lot in the assessment district shall be provided with a HC extending to the property line for a future connection. The HC should be located at that end of the vacant lot having the lowest elevation.

During the field investigation, a post card stating the proposed location of the upper end of the HC shall be left at each house or building to be served. The owner may indicate on the card a desired change of HC location and mail it to the Design Office concerned.

Post cards shall be numbered and the number of each card returned shall be shown in the appropriate lot on the plan. The property owner may change the location of the upper end of the HC at any time before construction. All requests for changes in location shall be in writing and shall be signed by the property owner.

F 481.2 CASH CONTRACT HOUSE CONNECTIONS

Every lot not previously sewered shall be provided with a "Wye" or "Tee". Where an existing sewer will be abandoned, each HC to the old line being utilized shall be provided with an outlet into the new sewer and connected. HCs connected to the old line not being utilized shall be investigated to determine their future need. If the Standard Plans are not applicable, details shall be provided on the

project plans. Street widening projects may require remodeling of existing HCs, if the widening results in less than 4 feet of cover over the existing pipe at the new property line. Another alternative to remodeling these HCs is to construct a concrete encasement around the existing HC. If the existing HC, that was previously in private property, will be within the public way and it is not less than 4 inches in size, it need not be increased to 6 inch. Any HC within the new public way that is less than 4 inches shall be remodeled with new 6 inch pipe. All HCs within the new public way 4 inch or less which are touched by the construction shall be upgraded to 6 inch.

F 481.3 CLASS "B" PERMIT PROJECT HOUSE CONNECTIONS

Private residential development projects processed under the Class "B" Permit system shall provide a HC to each lot shown on the plan. As discussed in Section F 483, when lot lines do not exist, it shall be assumed that the lots will be 50 feet wide. HCs to the main line shall be located on both sides of the main line and at the ends of the lots lowest in elevation. In areas that are undeveloped, and there are no plans for development, planning information shall be reviewed to determine the location of future connections.

F 481.31 UTILIZATION OF EXISTING HOUSE CONNECTION LATERALS INSTALLED PRIOR TO 1965 IN PERMIT RELATED CONSTRUCTION

The use of house connection laterals constructed prior to 1965 shall comply with the Bureau of Engineering Notice Number 007 dated January 24, 2007. The integrity of sewer house connection laterals constructed prior to 1965 shall be verified by Closed Circuit Television (CCTV) inspection prior to approval of continued use. Further, where an existing HC lateral is constructed of concrete pipe, which is found to be in acceptable condition, the pipe shall be rehabilitated by installation of an approved liner prior to approval of its continued use.

In conjunction with issuance of an S-Permit to a contractor or property owner for an extension of a pre- 1965 vitrified clay HC connection or any concrete HC or any reconnection at the property line, the permit shall specify CCTV inspection of the existing lateral and include the cost on one hour Special Inspection Fee for inspection by the Bureau of Contract Administration (BCA).

When CCTV inspection is required, the inspector's copy of the sewer permit shall be forwarded to the BCA rather than the Department of Building and Safety. The CCTV inspection shall be accomplished in the presence of the inspector prior to extension of or connection to the existing lateral. The inspector shall make a determination of the condition of the lateral and acknowledge the property line connection.

For concrete pipe house connections, either the entire lateral is to be replaced, or inspected by CCTV to verify the structural integrity, then rehabilitated by lining.

If the CCTV identifies that repair work is required, a supplemental permit can be issued if the original S-Permit was obtained by a bonded sewer contractor. However, if the original S-Permit was not issued to a bonded sewer contractor, a separate permit must be issued to a bonded sewer contractor to make any repairs, lining or extensions.

F 482 HOUSE CONNECTION REMODELING

HC remodeling shall conform to Standard Plan S-111 in the absence of unusual conditions. The project plans shall indicate the location of the remodeling and the case bedding to be utilized. Abandoned HCs shall be reported to the Wye Mapping Station so that these HCs may be deleted from the record maps.

F 483 HOUSE CONNECTION LOCATIONS

The main line sewer should have one "Wye" or "Tee" for each lot on each side of the main line. Where lot lines do not exist, the assumption should be made that lot lines will be 50 foot frontage lots on both sides. Where the property adjoining the sewer is other than low density residential, the location and sizes of "Wyes" or "Tees" should be determined from the best available information.

F 483.1 HOUSE CONNECTIONS ON HORIZONTAL CURVES

HCs on horizontal curves shall be detailed on the project plans. The HC schedule shall include:

a. Length and radius of curve
b. Chord offsets from a line joining two sequential MHs and distances along the line from the lower MH
c. Ties to locate the curve in the field

F 484 HOUSE CONNECTION DEPTH

Figure F 484 illustrates how to determine HC and mainline sewer depths. To establish the depth of the public sewer in reference to basements, it should generally be considered that the building drain depth, below the basement floor at the farthermost basement wall, will not be less than 2 feet and that the minimum slope of the building drain, sewer and HC will be 2 percent.

An allowance shall be made for the additional depth required for the rise of the "Tee" or "Wye" and 1/8 bend or 1/16 bend. The "Wye" branch on the public sewer may be inclined upward at an angle of approximately 45 degrees from the horizontal unless the "Wye" is specified to be laid flat. The vertical distances between the invert of the public sewer at the "Wye" location and the invert of the upper end of the 1/8 bend which connects the HC to the "Wye" branch of the public sewer is termed the "rise" (0.9 foot for 6-inch HC). See Table F 484 for the rise for 6 inch fittings.

Table F484

"WYE" RISE FOR 6 INCH FITTINGS WITH 1/8 BEND

Public Sewer Size (inches)	8	10	12	15	18	21	24
Rise (feet)	0.9	1.0	1.2	1.4	1.6	1.8	2.1

For determining the slope of the HC it may be assumed that the 1/8 bend terminates 2 feet laterally from the centerline of an 8 inch public sewer. If there will be a shallow sewer the "Wye" may be

specified to be laid flat. The rise shall be the difference between the radius of the public sewer and the radius of "Wye" branch, plus 1/4 inch.

On comparatively flat ground, the HC shall be deep enough to serve the entire lot. It is assumed that the building sewer will be constructed on a 2 percent slope from the rear portion of the lot. In those instances in which the connection will serve only the front portion of the property, or where the balance of the lot is obviously unsuitable for building purposes, a letter so stating shall be sent to the property owner.

A typical letter to inform a property owner of limited sewer service is as follows:

Dear Resident:

In conjunction with the Assessment Proceeding, which proposes the construction of a sanitary sewer in _____ _____ as ordered by the Los Angeles City Council in response to a petition of the property owners, this is to inform you that a sewer has been designed which can serve a future dwelling constructed approximately at the elevation of the street adjacent to the front portion of your property. Due to the unfavorable topography of your lot it would be very costly to construct a sewer at a depth that would serve more of your property at a lower elevation by gravity flow. Any plan to serve more of your lot would materially increase your assessment and the assessments on other property in the area and does not appear practical.

In the event you desire additional information on this matter, please communicate with (here describe and give the address and telephone number of the appropriate Division or District Office) within the next ten days.

Very truly yours,

_____, District Engineer

F 485 PROTECTION OF PROPOSED HOUSE CONNECTIONS

F 485.1 PROPOSED IMPROVEMENTS OVER PROPOSED HCs

HCs shall be designed to cross under storm drains or other subsurface improvements with a minimum clearance of 18 inches where practical. If the clearance will be between 6 and 18 inches, the HC shall be protected per Standard Plan S-111 along the entire width of the excavation for the proposed improvement. Where the clearance will be less than 6 inches, ductile iron pipe shall be specified.

F 485.2 PROPOSED IMPROVEMENTS ADJACENT TO PROPOSED HOUSE CONNECTIONS

If the horizontal clearance between a proposed HC and a proposed storm drain or other substructure will be less than 3 ft. that portion of the HC within 3 ft of the improvement shall be protected per Standard Plan S-111. The encasement shall extend 2 ft in each direction beyond the points where the horizontal clearance is 3 ft.

F 485.3 HOUSE CONNECTIONS WHICH JOIN NEW CHIMNEYS

HCs which are to join new chimneys shall be supported per Standard Plan S-253 for pipes partially crossing trenches or by an equivalent method approved by the Engineer.

F 486 PROTECTION OF EXISTING HOUSE CONNECTIONS

F 486.1 PROPOSED IMPROVEMENTS ABOVE EXISTING HOUSE CONNECTIONS

Where the clearance between the proposed storm drain or other substructure improvement will be between 8 and 12 inches, the existing HC sewer shall be blanketed per Standard Plan S-255 for the full width of the excavation for the improvement.

If the clearance will be less than 8 inches, either the existing HC sewer shall be remodeled in accordance with the Standard Plan S-111" House Connection Sewers Remodeling" or ductile iron pipe shall be installed in that portion of the HC sewer with less than 8 inches clearance.

Where, due to grading or street improvements, the cover of an existing HC will be between 2 and 4 feet below a surface with vehicular traffic, the HC shall be blanketed per Standard Plan S-255 as described above. For surfaces not subject to vehicular traffic, a HC shall be blanketed as above when the top of the barrel is to remain between 2 and 3 ft below the surface. When an HC is within 2 ft of a surface, it shall be relaid.

If existing HCs will remain in service, those portions that will be within the pressure zone of proposed pilings, piers, footing and fills, shall be protected as specified by SED.

F 486.2 PROPOSED IMPROVEMENTS BENEATH EXISTING HOUSE CONNECTIONS

Existing HCs shall be supported across trenches as detailed and specified per Standard Plan S-253 titled "Supports for Storm Drain and Sewer Pipes Across Trenches."

F 486.3 PROPOSED IMPROVEMENTS ADJACENT TO EXISTING HOUSE CONNECTIONS

When the horizontal clearance between proposed improvements and the existing HC sewer will be less than 3 ft, the HC sewer shall be blanketed per Standard Plan S-255.

If the clearance will be less than 8 inches, either the HC sewer shall be relocated in such a manner that the minimum clearance will exceed 8 inches, or ductile iron pipe shall be installed in that portion in which the clearance will be less than 8 inches. When a portion of the HC sewer is relocated, the relocated portion lying within 3 feet of the proposed improvement shall be protected with Case 5 bedding and the unrelocated proportion shall be blanketed per Standard Plan S-255.

F 487 TRAP HOUSE CONNECTION SEWER

The trap house connection sewer shown in Standard Plan S-112 shall be used at HC into a building. Instead of a MH structure, it has a riser that is capped. It shall be used when HCs are connected to a sewer with a diameter greater than 24-inches.

F 488 CHIMNEYS

Chimneys as shown in Standard Plan S-160 were specified where the mainline sewers were over 15 feet deep, (except where borings had shown groundwater existing at relatively shallow depths) and where several HCs in close proximity had to be connected to the main line. The purpose of the chimney was to preclude the necessity of having to construct deep excavations for the HCs. Chimneys shall be avoided (i.e., no deep sewers), but if necessary, chimneys shall be constructed only on those sewers designed to serve the adjacent property. They should be constructed to serve 4 lots, 2 on each side of the street.

Chimneys shall be constructed on "Tee" branches on the public sewer. They may also be constructed on existing "Wye" branches thereon. The type designated (Type X or Y) depends upon the fitting on the public sewer upon which the chimney is to be constructed.

The vertical pipe shall be 6 inch unless a larger size is required or HCs larger than 6 inch diameter will be joined. Both the upper portion and the base of the chimney shall be reinforced with the class of concrete specified on the applicable standard plan.

F 489 SADDLE CONNECTIONS

Whenever a connection is required, and there does not exist a "Wye" or "Tee" spur for a connection, a saddle connection shall be constructed. Saddles specified on a City project shall be installed by the City's contractor. Saddles installed under permit (LAMC Sec. 64.20) shall be installed by the Wastewater Collection Systems Division, BOS, only after the existing sewer has been adequately exposed by the permittee's contractor. (For fee schedule, see LAMC Section 64.20) When the connection is made to an interceptor or outfall sewer, or where the sewer is lined with plastic liner plate, all costs incurred by the City shall be charged to the permittee.

F 490 TRENCH EXCAVATION, BEDDING AND BACKFILL

See Construction requirements for trench excavation, bedding and backfill in the applicable sections of the SSPWC and as shown in 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. Brownbook modifies the SSPWC and where in conflict with them, supersedes them. The Brown Book covers requirements unique to City projects.

F 490.1 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 Standard Plan S-251 "Pipe Laying in Trenches".

F 490.2 BEDDING REQUIREMENTS FOR RCP

Bedding requirements for RCP shall be in accordance with Figures F490.2.C1, F490.2.C2, F490.2.C3, F490.C1B, F490.C2B, F490.C3B . "D-Loads for Reinforced Concrete Pipe". The plans shall call for construction of the appropriate bedding as shown on the Standard Plan S-251 "Pipe Laying in Trenches".

F 490.3 BEDDING REQUIREMENTS FOR PLASTIC PIPE

Special bedding design for plastic pipe shall be required under the following conditions:

a. Clay soils with a Plastic Index exceeding 10,
b. Fills compacted to less than 90%,
c. Areas where a planned future facility would require an excavation to the same or a greater depth and within 2 feet of the sewer trench,
d. Excavations requiring a depth to the pipe invert greater than 30 feet.

Otherwise bedding shall conform to Table F 490.3.

Table F 490.3

BEDDING REQUIREMENTS FOR PLASTIC PIPE IN TRENCHES

ABS, PVC, and PE solid wall pipe

Depth to Invert (feet)	Type Bedding
Less than 4	Case 5
4 to 16	Case 2
17 to 30	Case 4
Greater than 30	Special Design

ABS composite truss wall pipe, CCFRPM, PWPE, CPWPVC

Depth to Invert (feet)	Type Bedding
Less than 4	Case 5
4 to 8	Case 2 (see note 2)
9 to 20	Case 2
21 to 30	Case 4
Greater than 30	Special Design

NOTES

1. See Standard Plan S-251 "Pipe Laying in Trenches" for installation details of each case.
2. Bedding material may be Type "A".
3. Minimum wall thickness shall be SDR = 35.
4. Case 1 Bedding is not allowed under any condition.

F 491 RESPONSIBILITIES FOR SEWER PROJECT TRENCH REQUIREMENTS

The requirements for trenches, bedding and backfill shall be the responsibility of the Engineer, the SED and the GED shall provide all special requirements that may be necessary due to the prevailing soil and geologic conditions at the project site. The Engineer shall ensure that all necessary requirements are included in the project plans and specifications.

F 491.1 GEOTECHNICAL ENGINEER

Some of the responsibilities of the Geotechnical Engineer are set forth in Section F 330, et seq. The Geotechnical Engineer shall, upon receipt of the plans and specifications for the project, review the data to determine the adequacy of the plans and specifications. He shall use the soil boring data and the other geotechnical data available to determine any special excavation and shoring requirements. He shall also investigate if there are any archeological or paleontological zones of interest within the project area. If such zones are expected to be encountered during construction, the Engineer shall determine if the zones are of sufficient importance to advise other agencies of the proposed construction during the preliminary to design phase. The determination also shall be made whether the soil excavated during construction is suitable for bedding or backfill and if not, what requirements shall be included in the Geotechnical Data/Baseline Report for imported bedding and/or backfill.

F 491.2 STRUCTURAL ENGINEER

A copy of the Geotechnical Data/Baseline Report shall be transmitted to SED or its delegate. SED shall use this report to verify the adequacy of the shoring requirements, as well as excavation, bedding and backfill requirements. SED shall check the structural adequacy of the conduit to be utilized on the project and, if necessary, shall specify any additional strength class, bedding class, backfill or reinforcement and encasement requirements. Any special details for such structural items shall be prepared by and included in the plans and specifications by SED. Any special structural design not included in the Standard Plans shall also be prepared and included in the plans by SED (See F 331.2).

F 491.3 STREET ENGINEER

The Street Design Section of Bridge, Street, and Stormwater program shall review the sewer plans resurfacing schedule. Coordination between the Sewer Design and Street Design Sections is imperative to ensure protection of the street surface. Locations of longitudinal and transverse joints shall be determined and included in the plans. Matters concerning street closures, pedestrian crosswalks, handicapped ramps, landscaping problems, including tree trimming and removals shall be coordinated with the Bureau of Street Services.

F 493 TRENCH EXCAVATION LIMITATIONS

Trench excavations shall comply with the SSPWC which, in general, meet requirements for City projects with modifications on Standard Plan S-251. Special requirements shall be determined, and listed on the plans or the Specifications. Deep excavations shall be investigated for possible realignment, either horizontally or vertically. Tunnel or jacking alternatives should also be considered.

Trench widths shall be per SSPWC and the Standard Plans. When wider trench widths are necessary, SED and the GED shall be consulted.

The length of open trenches is limited by SSPWC. In some cases, a shorter than normal length of open trench may be required for traffic or safety concerns. When a restriction is requested by other agencies, the Engineer shall review the request to determine if the reduction of open trench length is feasible and necessary.

F 494 BEDDING, BACKFILL, CONSOLIDATION AND COMPACTION

Bedding, backfill, consolidation and compaction shall be per the Standard Specification, and Standard Plan S-251. Upon the recommendations of either SED or GED, special requirements shall be listed in the plans or the Specifications.

Special bedding and backfill requirements may be necessary when utilities exist in the same trench as that proposed for the new sewer or immediately adjacent to the same trench.

F 495 PIPE ANCHORAGE AND EROSION CONTROL OVER BACKFILL SURFACES

Pipe anchors and erosion control devices required shall be per Standard Plan S-252. The Engineer, with the assistance of SED and GED, shall determine the necessity, if any, for these devices. In those cases when the standard designs for these devices are not applicable, special designs shall be detailed on the plans. Special designs shall not be used unless necessary because they may incur higher construction costs.

Erosion control might be provided by landscaping the area. The plans and Special Provisions shall include all such requirements. If so, the Bureau's landscape architects determine the requirements and prepare the necessary plans and specifications.

F 496 TRENCH RESURFACING

Temporary and permanent resurfacing shall be per SSPWC and the Resurfacing Schedule. The Bureau of Street Services will advise the Engineer of these requirements and will prepare the necessary plans and specifications where the Standard Plans and SSPWC are insufficient.

The Resurfacing Schedule shall include the existing pavement type and thickness. Resurfacing shall be minimized to the amount of pavement removal required on a project. Temporary resurfacing shall also be minimized. (See F 491.3).

F 497 SUBSTRUCTURE PROTECTION

The contractor shall protect existing and identified utilities. The Engineer shall be responsible for showing all known substructures on the plans. Special diligence shall be given to identify unstable substance substructures.

a. The following steps summarize the policy and procedure for investigation, verification and delineation of substructures on plans. See F 321.3, et. seq. During the design phase of a project, the design office shall identify and determine the location of all substructures that may conflict with or be affected by any proposed improvement. All available substructure records shall be checked, including unposted "As-Built" utility plans and pending utility permits. All such substructures shall be shown on the project plans. Preliminary plans shall be transmitted to substructure owners for verification of location and identity of their facility. Substructure owners shall also be requested to advise of their future plans and needs for the area involved.

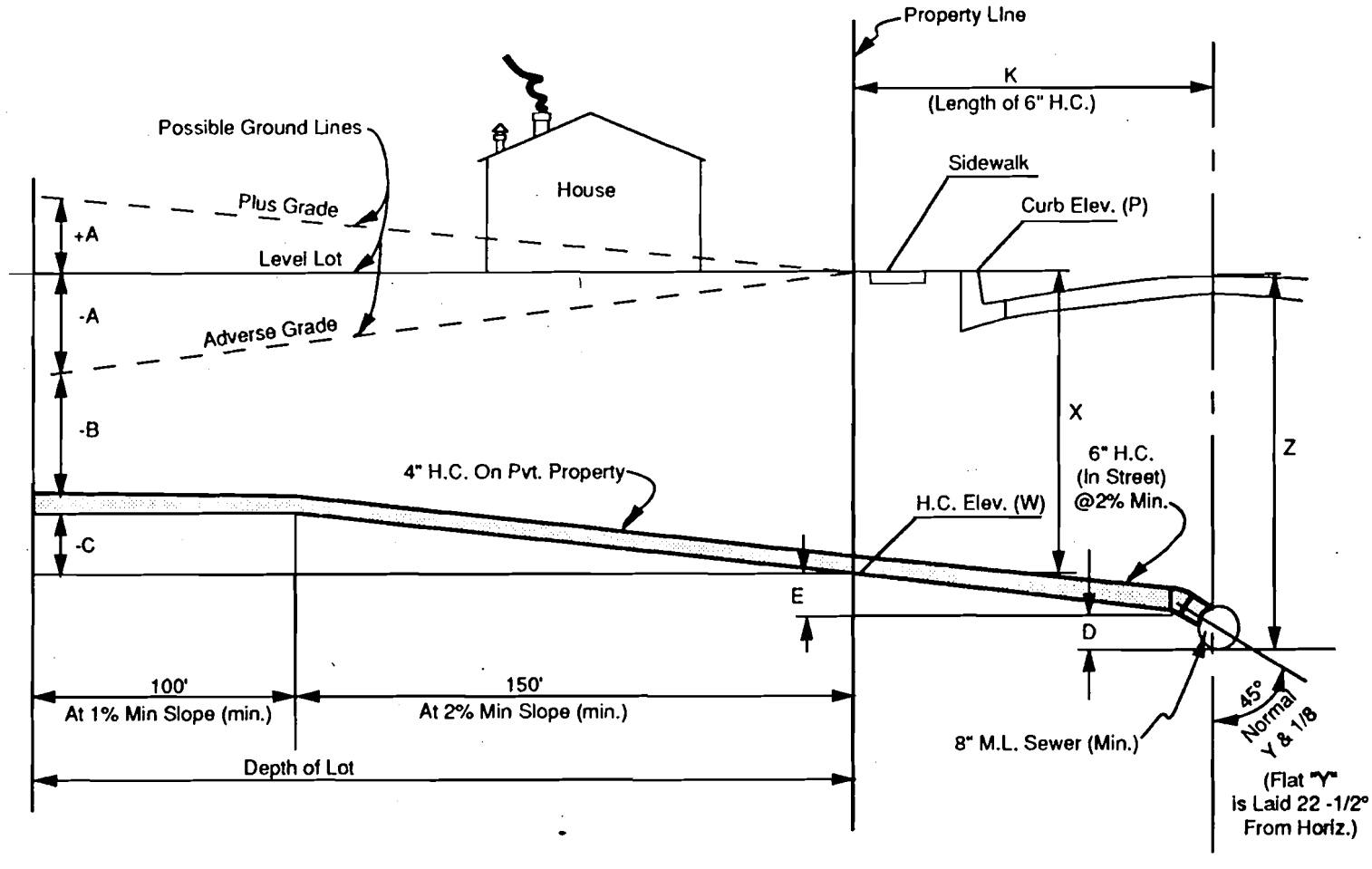
b. The substructure owner shall be requested to pothole any substructure carrying unstable substances to determine depth and location where the proposed excavation is crossed, and at intervals of not more than 100 feet when the proposed excavation is parallel to and within 6 feet of the substructure. A "no-fee" excavation permit shall accompany the request. When the design office considers it necessary or advisable, the potholing of other substructures may be requested. Potholing shall include exposing the substructure sufficiently to determine the horizontal and vertical location and limits. All information determined by potholing shall be shown on the project plans.

c. Prior to advertisement for bids, the design office, in connection with the Project Award and Control Division (PAC) shall review the substructure records to determine if there are recent or proposed installations that affect the design or are within the proximity indicated in paragraph b above. Appropriate action shall be initiated by the design office to either pothole recently installed substructures carrying unstable substances and show their location and depth on the plans by revision, or request the PAC to include a suitable provision in the Notice to Bidders requiring the contractor to perform the potholing of such substructures. The provision should limit the use of power tools to pavement breaking.

d. The PAC shall be responsible for utility coordination through the use of Utility Notices and Utility coordinating meetings. The Design Office and Bureau of Contract Administration shall be invited to all such meetings.

e. Where abandonment or relocation of substructures is required to resolve conflicts, permits should be carefully reviewed for adequacy. Adherence to permit requirements should be verified in the field by monitoring the work, and the design office is assigned this responsibility.

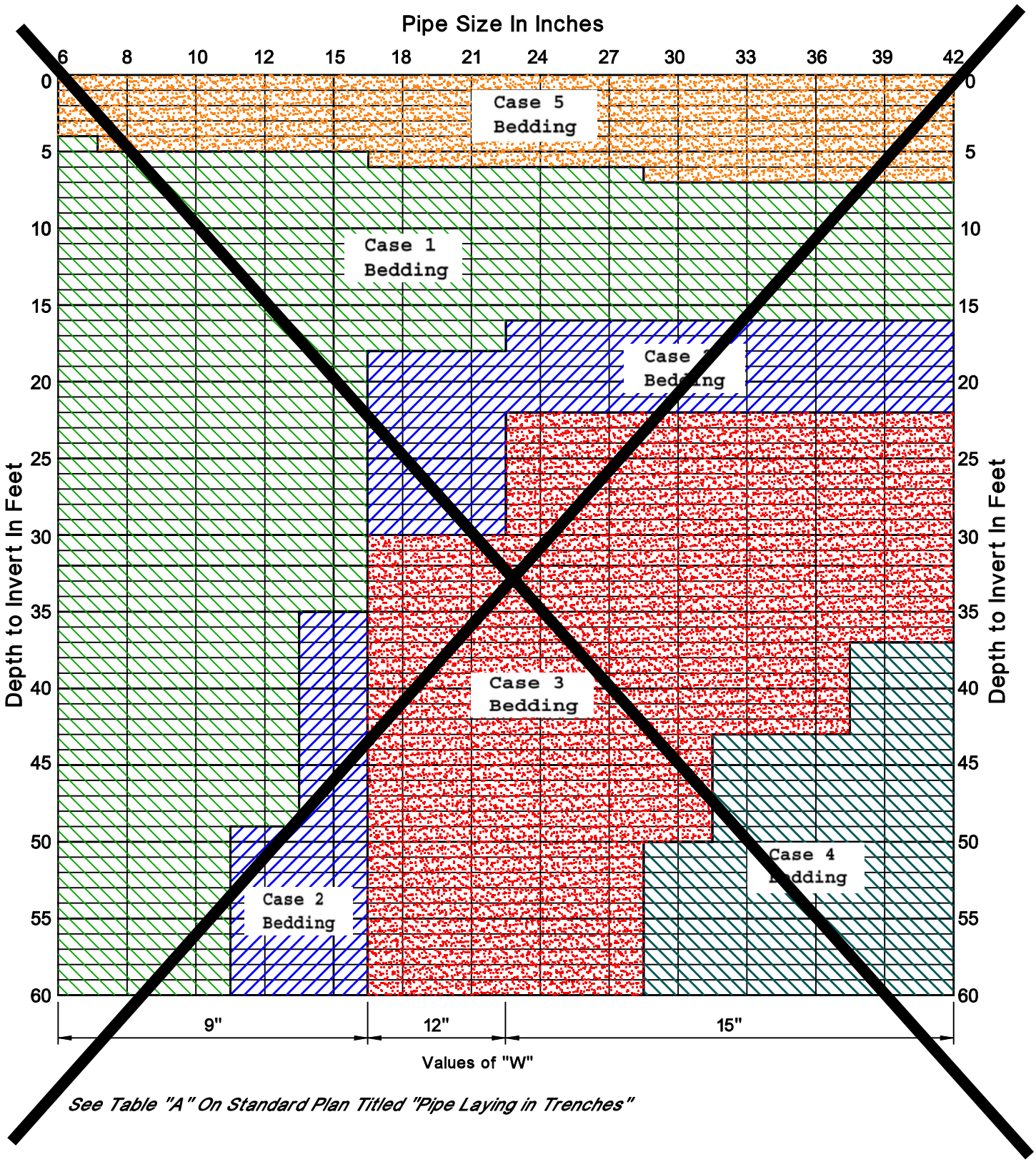
f. Relocated or abandoned utilities will be reflected in the substructure records through the filing of "As-Built" plans by the substructure owner.



Legend and Definition of Letters:

A = Difference in elev. of back of lot above or below curb.
B = Amount of cover - 1 1/2' for foundation house or 3' for slab.
C = Rise in pipe due to 1% & 2% slope.
D = Allowance for "Y" & 1/8 bend = .9' normal & .1' for flat "Y".
E = Rise of 6" H.C. due to 2% slope for distance K.
W = H.C. Elev. = P-X (where p = curb elev.)
X = Depth below curb required for H.C. X = A+B+C (algebraicly)
Z = X+E+D = Invert depth of main line
M.L. = Mainline Sewer
H.C. = House Connection Sewer

Method of Determining House Connection and Main Line Depths
Figure F484

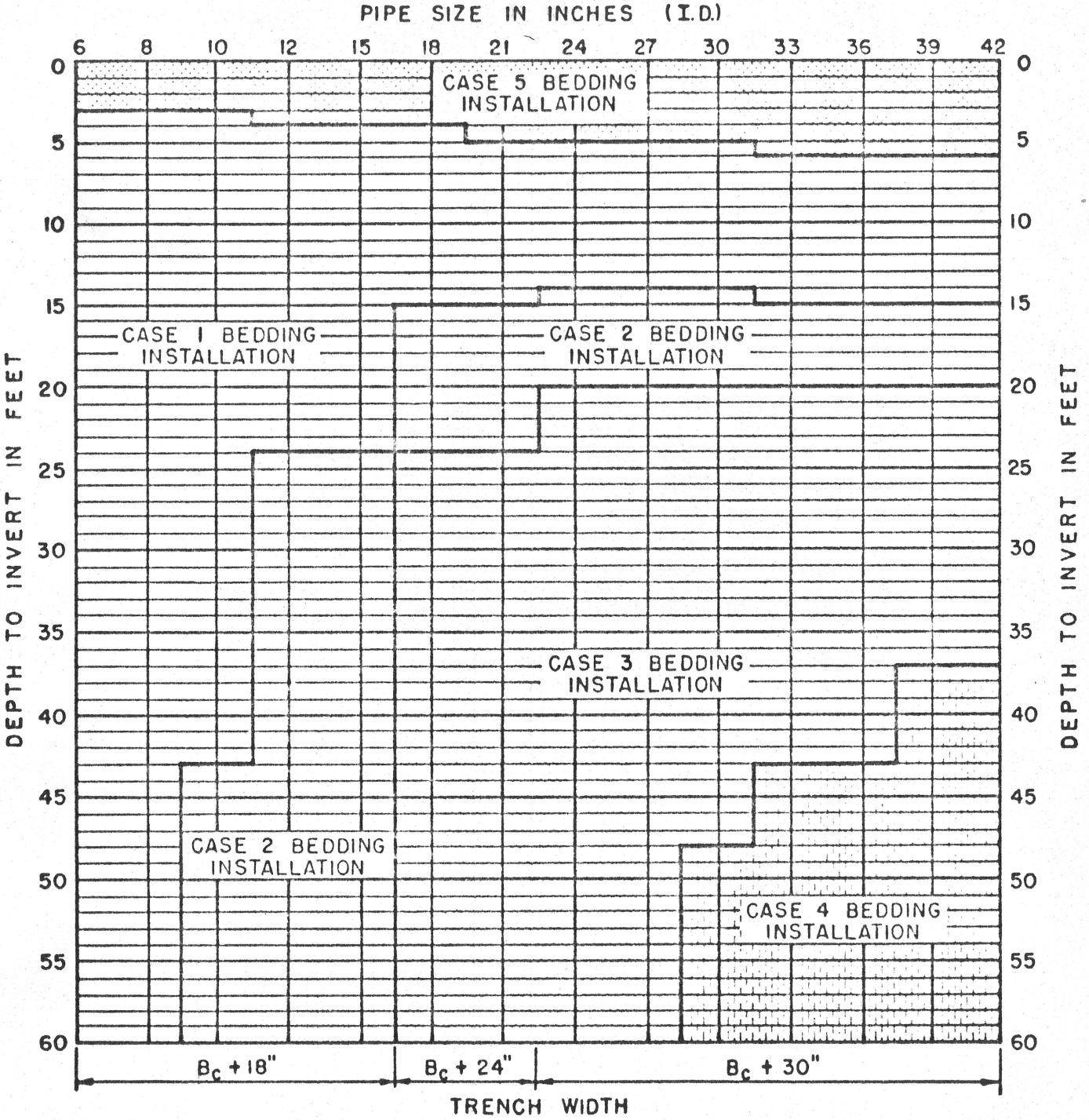


Bedding Requirements for Clay Pipe In Trenches

Figure F490.1

SEE REVISED Figure F 490.1
Bedding Requirements for Clay Pipe in Trenches
<< Next Page >>

DESIGN STANDARD FOR CLAY PIPE IN TRENCHES



SEE STANDARD PLAN TITLED "PIPE LAYING IN TRENCHES"

STRUCTURAL ENGINEERING DIVISION B.C.-J.H.-6-77 ~~Fig. F 242.3~~

Figure F 490.1
Bedding Requirements for Clay Pipe in Trenches
(Figure number revised from F242.3 to F490-1 on 4/30/19)

D-LOADS FOR REINFORCED CONCRETE PIPE WITHOUT BELLS (SEWER, CASE I BEDDING)

PIPE I.D. (inches)	COVER TO TOP OF PIPE (FEET)																														PIPE I.D. (inches)
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	1100	1100	1100	1500	1400	1500	1700	1900	2100	1600	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3100	3200	3200	3300	3400	3400	42
45*	1000	1000	1100	1400	1400	1500	1700	1900	2100	1600	1700	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3100	3200	3300	3300	3400	3400	45*
48	900	900	1000	1300	1400	1500	1700	1900	2000	1600	1700	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3100	3200	3300	3300	3400	3400	48
51*	800	900	900	1200	1300	1500	1600	1800	2000	1600	1700	1800	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3200	3200	3300	3400	3400	3500	51*
54	800	800	900	1200	1300	1400	1600	1800	2000	1600	1700	1800	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3200	3200	3300	3400	3400	3500	54
57*	800	800	800	1100	1300	1400	1600	1800	1900	1600	1700	1800	1900	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3000	3100	3200	3300	3300	3400	3400	3500	57*
60	800	800	800	1100	1300	1400	1600	1700	1900	1500	1700	1800	1900	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3000	3100	3200	3300	3300	3400	3500	3500	60
63*	800	800	800	1000	1250	1350	1500	1700	1850	1500	1650	1800	1900	2050	2150	2250	2350	2450	2550	2650	2750	2850	2950	3000	3100	3200	3250	3350	3400	3450	3550	63*
66	800	800	800	1000	1200	1350	1500	1650	1800	1500	1650	1750	1900	2000	2150	2250	2350	2450	2550	2650	2750	2850	2950	3050	3100	3200	3250	3350	3400	3500	3550	66
69*	800	800	800	950	1200	1350	1450	1650	1800	1500	1650	1750	1900	2000	2150	2250	2350	2450	2550	2650	2750	2850	2950	3050	3100	3200	3300	3350	3450	3500	3550	69*
72	800	800	800	950	1200	1300	1450	1650	1750	1500	1650	1750	1900	2000	2150	2250	2350	2450	2550	2700	2750	2850	2950	3050	3150	3200	3300	3350	3450	3500	3600	72
75*	800	800	800	900	1200	1300	1450	1600	1750	1500	1600	1750	1900	2000	2150	2250	2350	2450	2600	2700	2800	2850	2950	3050	3150	3200	3300	3400	3450	3550	3600	75*
78	800	800	800	900	1150	1300	1450	1600	1750	1500	1600	1750	1900	2000	2150	2250	2350	2450	2600	2700	2800	2900	2950	3050	3150	3250	3300	3400	3500	3550	3600	78
81*	800	800	800	850	1150	1250	1400	1600	1700	1500	1600	1750	1900	2000	2150	2250	2350	2450	2600	2700	2800	2900	3000	3050	3150	3250	3350	3400	3500	3550	3650	81*
84	800	800	800	850	1150	1250	1400	1550	1700	1450	1600	1750	1900	2000	2100	2250	2350	2450	2600	2700	2800	2900	3000	3100	3150	3250	3350	3400	3500	3600	3650	84
87*	800	800	800	800	1150	1250	1400	1550	1700	1450	1600	1750	1850	2000	2100	2250	2350	2450	2600	2700	2800	2900	3000	3100	3200	3250	3350	3450	3500	3600	3650	87*
90	800	800	800	900	1100	1250	1400	1550	1700	1450	1600	1750	1850	2000	2100	2250	2350	2450	2600	2700	2800	2900	3000	3100	3200	3250	3350	3450	3550	3600	3700	90
93*	800	800	800	850	1100	1250	1350	1550	1650	1450	1600	1750	1850	2000	2100	2250	2350	2450	2600	2700	2800	2900	3000	3100	3200	3300	3350	3450	3550	3650	3700	93*
96	800	800	800	850	1050	1200	1350	1500	1650	1450	1600	1750	1850	2000	2100	2250	2350	2450	2600	2700	2800	2900	3000	3100	3200	3300	3400	3450	3550	3650	3700	96
102	800	800	800	800	1050	1200	1350	1500	1650	1500	1650	1800	1900	2050	2200	2300	2450	2550	2700	2800	2900	3000	3100	3250	3350	3450	3550	3600	3700	3800	3900	102
108	800	800	800	800	1000	1150	1350	1500	1600	1500	1650	1800	1900	2050	2200	2300	2450	2550	2700	2800	2900	3000	3150	3250	3350	3450	3550	3650	3750	3800	3900	108

POSITIVE PROJECTION CONDITION — **UNLIMITED TRENCH WIDTH**

TRENCH CONDITION — **LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW**

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP without Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
$K\mu'$ = 0.15 for trench condition;
$K\mu$ = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 1.4 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

LEGEND

Requires special design and order, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe without Bells, Case I Bedding
Figure F490.2.C1

PIPE I.D. (inches)	D-LOADS FOR REINFORCED CONCRETE PIPE WITHOUT BELLS (SEWER, CASE II BEDDING)																														PIPE I.D. (inches)
	COVER TO TOP OF PIPE (FEET)																														
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	800	900	900	1100	1100	1200	1400	1500	1700	1300	1400	1500	1600	1700	1700	1800	1900	2000	2000	2100	2200	2200	2300	2300	2400	2400	2500	2500	2600	2600	2700	**42**
45*	800	800	800	1100	1100	1200	1300	1500	1600	1300	1400	1500	1600	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2300	2400	2500	2500	2500	2600	2600	2700	**45***
48	800	800	800	1000	1100	1200	1300	1500	1600	1200	1400	1500	1500	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2400	2400	2500	2500	2600	2600	2600	2700	**48**
51*	800	800	800	1000	1100	1100	1300	1400	1600	1200	1300	1400	1500	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2400	2400	2500	2500	2600	2600	2700	2700	**51***
54	800	800	800	900	1000	1100	1300	1400	1500	1200	1300	1400	1500	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2400	2400	2500	2500	2600	2600	2700	2700	**54**
57*	800	800	800	900	1000	1100	1200	1400	1500	1200	1300	1400	1500	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2400	2400	2500	2500	2600	2600	2700	2700	**57***
60	800	800	800	900	1000	1100	1200	1400	1500	1200	1300	1400	1500	1600	1700	1800	1900	2000	2000	2100	2200	2200	2300	2400	2400	2500	2600	2600	2700	2700	2800	**60**
63*	800	800	800	800	950	1050	1200	1300	1450	1200	1300	1400	1500	1600	1650	1750	1850	1950	2000	2100	2150	2200	2300	2350	2400	2500	2550	2600	2650	2700	2750	**63***
66	800	800	800	800	950	1050	1150	1300	1400	1200	1300	1400	1500	1600	1650	1750	1850	1950	2000	2100	2150	2250	2300	2350	2450	2500	2550	2600	2650	2700	2750	**66**
69*	800	800	800	800	950	1050	1150	1300	1400	1150	1300	1400	1500	1600	1650	1750	1850	1950	2000	2100	2150	2250	2300	2350	2450	2500	2550	2600	2650	2750	2800	**69***
72	800	800	800	800	950	1050	1150	1250	1400	1150	1250	1400	1500	1550	1650	1750	1850	1950	2000	2100	2150	2250	2300	2350	2450	2500	2550	2650	2700	2750	2800	**72**
75*	800	800	800	800	900	1000	1150	1250	1350	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2150	2250	2300	2400	2450	2500	2600	2650	2700	2750	2800	**75***
78	800	800	800	800	900	1000	1100	1250	1350	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2150	2250	2300	2400	2450	2500	2600	2650	2700	2750	2800	**78**
81*	800	800	800	800	900	1000	1100	1250	1350	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2150	2250	2300	2400	2450	2550	2600	2650	2700	2800	2850	**81***
84	800	800	800	800	900	1000	1100	1250	1350	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2150	2250	2350	2400	2450	2550	2600	2650	2750	2800	2850	**84**
87*	800	800	800	800	900	1000	1100	1200	1300	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2200	2250	2350	2400	2500	2550	2600	2700	2750	2800	2850	**87***
90	800	800	800	800	850	950	1100	1200	1300	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2200	2250	2350	2400	2500	2550	2600	2700	2750	2800	2900	**90**
93*	800	800	800	800	850	950	1050	1200	1300	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2200	2250	2350	2400	2500	2550	2650	2700	2750	2850	2900	**93***
96	800	800	800	800	850	950	1050	1200	1300	1150	1250	1350	1450	1550	1650	1750	1850	1950	2000	2100	2200	2250	2350	2400	2500	2550	2650	2700	2750	2850	2900	**96**
102	800	800	800	800	800	950	1050	1150	1300	1150	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2250	2350	2450	2500	2600	2650	2750	2800	2900	2950	3050	**102**
108	800	800	800	800	800	900	1050	1150	1250	1150	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2250	2350	2450	2500	2600	2700	2750	2850	2900	3000	3050	**108**
	POSITIVE PROJECTION CONDITION									**TRENCH CONDITION**																						
	UNLIMITED TRENCH WIDTH									**LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW**																						

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP without Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
$K\mu'$ = 0.15 for trench condition;
$K\mu$ = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 1.8 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

LEGEND

Requires special design and order, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe without Bells, Case II Bedding
Figure F490.2.C2

PIPE I.D. (inches)	D-LOADS FOR REINFORCED CONCRETE PIPE WITHOUT BELLS (SEWER, CASE III BEDDING)																														PIPE I.D. (inches)
	COVER TO TOP OF PIPE (FEET)																														
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	800	800	800	800	800	800	900	1000	1100	900	900	1000	1100	1100	1200	1200	1300	1300	1400	1400	1500	1500	1500	1600	1600	1600	1700	1700	1700	1800	1800	42
45*	800	800	800	800	800	800	900	1000	1100	900	900	1000	1100	1100	1200	1200	1300	1300	1400	1400	1500	1500	1500	1600	1600	1700	1700	1700	1700	1800	1800	45*
48	800	800	800	800	800	800	900	1000	1100	800	900	1000	1000	1100	1200	1200	1300	1300	1400	1400	1500	1500	1500	1600	1600	1700	1700	1700	1800	1800	1800	48
51*	800	800	800	800	800	800	900	1000	1100	800	900	1000	1000	1100	1200	1200	1300	1300	1400	1400	1500	1500	1500	1600	1600	1700	1700	1700	1800	1800	1800	51*
54	800	800	800	800	800	800	900	1000	1000	800	900	1000	1000	1100	1200	1200	1300	1300	1400	1400	1500	1500	1600	1600	1600	1700	1700	1700	1800	1800	1800	54
57*	800	800	800	800	800	800	800	900	1000	800	900	1000	1000	1100	1200	1200	1300	1300	1400	1400	1500	1500	1600	1600	1600	1700	1700	1700	1800	1800	1800	57*
60	800	800	800	800	800	800	800	900	1000	800	900	1000	1000	1100	1200	1200	1300	1300	1400	1400	1500	1500	1600	1600	1600	1700	1700	1800	1800	1800	1900	60
63*	800	800	800	800	800	800	800	900	950	800	850	950	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1600	1650	1700	1750	1750	1800	1850	63*
66	800	800	800	800	800	800	800	900	950	800	850	950	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1650	1700	1750	1800	1800	1850	66
69*	800	800	800	800	800	800	800	850	950	800	850	950	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1650	1700	1750	1800	1850	1850	69*
72	800	800	800	800	800	800	800	850	950	800	850	950	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1700	1750	1800	1850	1850	72
75*	800	800	800	800	800	800	800	850	900	800	850	900	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1750	1800	1850	1900	75*
78	800	800	800	800	800	800	800	850	900	800	850	900	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1750	1800	1850	1900	78
81*	800	800	800	800	800	800	800	850	900	800	850	900	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1800	1850	1900	81*
84	800	800	800	800	800	800	800	850	900	800	850	900	1000	1050	1100	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1850	1900	84
87*	800	800	800	800	800	800	800	800	900	800	850	900	1000	1050	1100	1150	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1900	87*
90	800	800	800	800	800	800	800	800	900	800	850	900	1000	1050	1100	1150	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	90
93*	800	800	800	800	800	800	800	800	900	800	850	900	1000	1050	1100	1150	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	93*
96	800	800	800	800	800	800	800	800	850	800	850	900	1000	1050	1100	1150	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	96
102	800	800	800	800	800	800	800	800	850	800	850	950	1000	1100	1150	1200	1300	1350	1400	1450	1500	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	102
108	800	800	800	800	800	800	800	800	850	800	850	950	1000	1050	1150	1200	1250	1350	1400	1450	1500	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	108

POSITIVE PROJECTION CONDITION

UNLIMITED TRENCH WIDTH

TRENCH CONDITION

LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP without Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
$K\mu'$ = 0.15 for trench condition;
$K\mu$ = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 2.7 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe without Bells, Case III Bedding
Figure F490.2.C3

D-LOADS FOR REINFORCED CONCRETE PIPE WITH BELLS (SEWER, CASE I BEDDING)

PIPE I.D. (inches)	COVER TO TOP OF PIPE (FEET)																														PIPE I.D. (inches)
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	1100	1100	1100	1500	1400	1500	1700	1900	2100	1900	2100	2300	2400	2600	2700	2900	3000	3100	3200	3300	3400	3600	3700	3700	3800	3900	4000	4100	4200	4200	4300	42
45*	1000	1000	1100	1400	1400	1500	1700	1900	2100	1900	2100	2200	2400	2500	2700	2800	2900	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4100	4200	4300	45*
48	900	900	1000	1300	1400	1500	1700	1900	2000	1900	2000	2200	2300	2500	2600	2800	2900	3000	3100	3300	3400	3500	3600	3700	3800	3900	3900	4000	4100	4200	4300	48
51*	800	900	900	1200	1300	1500	1600	1800	2000	1800	2000	2200	2300	2500	2600	2700	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4200	4200	51*
54	800	800	900	1200	1300	1400	1600	1800	2000	1800	2000	2100	2300	2400	2600	2700	2800	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4200	4200	54
57*	800	800	800	1100	1300	1400	1600	1800	1900	1800	2000	2100	2300	2400	2500	2700	2800	2900	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4100	4200	57*
60	800	800	800	1100	1300	1400	1600	1700	1900	1800	1900	2100	2200	2400	2500	2700	2800	2900	3000	3200	3300	3400	3500	3600	3700	3800	3900	4000	4000	4100	4200	60
63*	800	800	800	1000	1250	1350	1500	1700	1850	1750	1900	2050	2200	2350	2500	2600	2750	2850	3000	3100	3200	3350	3450	3550	3650	3750	3850	3900	4000	4100	4200	63*
66	800	800	800	1000	1200	1350	1500	1650	1800	1700	1850	2050	2150	2300	2450	2600	2700	2850	2950	3100	3200	3300	3450	3550	3650	3750	3800	3900	4000	4100	4150	66
69*	800	800	800	950	1200	1350	1450	1650	1800	1700	1850	2000	2150	2300	2450	2600	2700	2850	2950	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4150	69*
72	800	800	800	950	1200	1300	1450	1650	1750	1700	1850	2000	2150	2300	2450	2550	2700	2800	2950	3050	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4150	72
75*	800	800	800	900	1200	1300	1450	1600	1750	1650	1850	2000	2150	2250	2400	2550	2700	2800	2950	3050	3150	3300	3400	3500	3600	3700	3800	3900	4000	4100	4150	75*
78	800	800	800	900	1150	1300	1450	1600	1750	1650	1800	1950	2100	2250	2400	2550	2650	2800	2900	3050	3150	3250	3400	3500	3600	3700	3800	3900	4000	4100	4150	78
81*	800	800	800	850	1150	1250	1400	1600	1700	1650	1800	1950	2100	2250	2400	2500	2650	2800	2900	3050	3150	3250	3350	3500	3600	3700	3800	3900	4000	4050	4150	81*
84	800	800	800	850	1150	1250	1400	1550	1700	1650	1800	1950	2100	2250	2400	2500	2650	2750	2900	3000	3150	3250	3350	3500	3600	3700	3800	3900	4000	4050	4150	84
87*	800	800	800	800	1150	1250	1400	1550	1700	1650	1800	1950	2100	2250	2350	2500	2650	2750	2900	3000	3150	3250	3350	3450	3600	3700	3800	3900	4000	4050	4150	87*
90	800	800	800	900	1100	1250	1400	1550	1700	1600	1750	1950	2050	2200	2350	2500	2650	2750	2900	3000	3100	3250	3350	3450	3550	3700	3800	3900	4000	4050	4150	90
93*	800	800	800	850	1100	1250	1350	1550	1650	1600	1750	1900	2050	2200	2350	2500	2600	2750	2850	3000	3100	3250	3350	3450	3550	3700	3800	3900	4000	4100	4150	93*
96	800	800	800	850	1050	1200	1350	1500	1650	1600	1750	1900	2050	2200	2350	2500	2600	2750	2850	3000	3100	3250	3350	3450	3550	3650	3800	3900	4000	4100	4150	96
102	800	800	800	800	1050	1200	1350	1500	1650	1600	1750	1900	2050	2200	2350	2450	2600	2750	2850	3000	3100	3200	3350	3450	3550	3650	3800	3900	4000	4100	4200	102
108	800	800	800	800	1000	1150	1350	1500	1600	1600	1750	1900	2050	2150	2300	2450	2600	2700	2850	2950	3100	3200	3350	3450	3550	3650	3750	3900	4000	4100	4200	108

POSITIVE PROJECTION CONDITION

UNLIMITED TRENCH WIDTH

TRENCH CONDITION

LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP with Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
$K\mu'$ = 0.15 for trench condition;
$K\mu$ = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 1.4 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

LEGEND

Requires special design and order, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe with Bells, Case I Bedding
Figure F490.2.C1B

PIPE I.D. (inches)	D-LOADS FOR REINFORCED CONCRETE PIPE WITH BELLS (SEWER, CASE II BEDDING)																													PIPE I.D. (inches)
	COVER TO TOP OF PIPE (FEET)																													
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	800	900	900	1100	1100	1200	1400	1500	1700	1500	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	2900	3000	3100	3100	3200	3300	3300	3400	42
45*	800	800	800	1100	1100	1200	1300	1500	1600	1500	1600	1700	1900	2000	2100	2200	2300	2400	2500	2600	2700	2700	2800	2900	3000	3000	3100	3200	3200	3300	3300	45*
48	800	800	800	1000	1100	1200	1300	1500	1600	1500	1600	1700	1800	2000	2100	2200	2300	2400	2500	2500	2600	2700	2800	2900	2900	3000	3100	3100	3200	3300	3300	48
51*	800	800	800	1000	1100	1100	1300	1400	1600	1400	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2800	2900	3000	3100	3100	3200	3300	3300	51*
54	800	800	800	900	1000	1100	1300	1400	1500	1400	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2800	2900	3000	3000	3100	3200	3200	3300	54
57*	800	800	800	900	1000	1100	1200	1400	1500	1400	1500	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2700	2800	2900	3000	3000	3100	3200	3200	3300	57*
60	800	800	800	900	1000	1100	1200	1400	1500	1400	1500	1600	1800	1900	2000	2100	2200	2300	2400	2500	2600	2600	2700	2800	2900	2900	3000	3100	3200	3200	3300	60
63*	800	800	800	800	950	1050	1200	1300	1450	1350	1500	1600	1700	1800	1950	2050	2150	2250	2350	2400	2500	2600	2700	2750	2850	2900	3000	3050	3150	3200	3250	63*
66	800	800	800	800	950	1050	1150	1300	1400	1350	1450	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2650	2750	2850	2900	3000	3050	3100	3200	3250	66
69*	800	800	800	800	950	1050	1150	1300	1400	1350	1450	1550	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2650	2750	2800	2900	2950	3050	3100	3200	3250	69*
72	800	800	800	800	950	1050	1150	1250	1400	1300	1450	1550	1650	1800	1900	2000	2100	2200	2300	2400	2500	2550	2650	2750	2800	2900	2950	3050	3100	3200	3250	72
75*	800	800	800	800	900	1000	1150	1250	1350	1300	1450	1550	1650	1750	1900	2000	2100	2200	2300	2400	2450	2550	2650	2750	2800	2900	2950	3050	3100	3200	3250	75*
78	800	800	800	800	900	1000	1100	1250	1350	1300	1400	1550	1650	1750	1850	2000	2100	2200	2300	2350	2450	2550	2650	2700	2800	2900	2950	3050	3100	3200	3250	78
81*	800	800	800	800	900	1000	1100	1250	1350	1300	1400	1550	1650	1750	1850	1950	2050	2150	2250	2350	2450	2550	2650	2700	2800	2900	2950	3050	3100	3150	3250	81*
84	800	800	800	800	900	1000	1100	1250	1350	1300	1400	1500	1650	1750	1850	1950	2050	2150	2250	2350	2450	2550	2600	2700	2800	2850	2950	3050	3100	3150	3250	84
87*	800	800	800	800	900	1000	1100	1200	1300	1250	1400	1500	1650	1750	1850	1950	2050	2150	2250	2350	2450	2550	2600	2700	2800	2850	2950	3050	3100	3150	3250	87*
90	800	800	800	800	850	950	1100	1200	1300	1250	1400	1500	1600	1750	1850	1950	2050	2150	2250	2350	2450	2550	2600	2700	2800	2850	2950	3000	3100	3150	3250	90
93*	800	800	800	800	850	950	1050	1200	1300	1250	1400	1500	1600	1700	1850	1950	2050	2150	2250	2350	2450	2500	2600	2700	2800	2850	2950	3000	3100	3200	3250	93*
96	800	800	800	800	850	950	1050	1200	1300	1250	1350	1500	1600	1700	1850	1950	2050	2150	2250	2350	2450	2500	2600	2700	2800	2850	2950	3000	3100	3200	3250	96
102	800	800	800	800	800	950	1050	1150	1300	1250	1350	1500	1600	1700	1800	1900	2000	2150	2250	2300	2400	2500	2600	2700	2800	2850	2950	3000	3100	3200	3250	102
108	800	800	800	800	800	900	1050	1150	1250	1250	1350	1450	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2750	2850	2950	3000	3100	3200	3250	108

POSITIVE PROJECTION CONDITION

UNLIMITED TRENCH WIDTH

TRENCH CONDITION

LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP with Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
K_{μ}' = 0.15 for trench condition;
K_{μ} = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 1.8 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

LEGEND

Requires special design and order, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe with Bells, Case II Bedding
Figure F490.2.C2B

PIPE I.D. (inches)	D-LOADS FOR REINFORCED CONCRETE PIPE WITH BELLS (SEWER, CASE III BEDDING)																														PIPE I.D. (inches)
	COVER TO TOP OF PIPE (FEET)																														
	1	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
42	800	800	800	800	800	800	900	1000	1100	1000	1100	1200	1300	1400	1400	1500	1600	1600	1700	1800	1800	1900	1900	2000	2000	2100	2100	2100	2200	2200	2300	**42**
45*	800	800	800	800	800	800	900	1000	1100	1000	1100	1200	1300	1300	1400	1500	1500	1600	1700	1700	1800	1800	1900	1900	2000	2000	2100	2100	2200	2200	2200	**45***
48	800	800	800	800	800	800	900	1000	1100	1000	1100	1200	1200	1300	1400	1500	1500	1600	1700	1700	1800	1800	1900	1900	2000	2000	2100	2100	2200	2200	2200	**48**
51*	800	800	800	800	800	800	900	1000	1100	1000	1100	1100	1200	1300	1400	1400	1500	1600	1600	1700	1800	1800	1900	1900	2000	2000	2100	2100	2100	2200	2200	**51***
54	800	800	800	800	800	800	900	1000	1000	1000	1100	1100	1200	1300	1400	1400	1500	1600	1600	1700	1700	1800	1900	1900	2000	2000	2000	2100	2100	2200	2200	**54**
57*	800	800	800	800	800	800	800	900	1000	1000	1000	1100	1200	1300	1300	1400	1500	1500	1600	1700	1700	1800	1800	1900	1900	2000	2000	2100	2100	2200	2200	**57***
60	800	800	800	800	800	800	800	900	1000	900	1000	1100	1200	1300	1300	1400	1500	1500	1600	1700	1700	1800	1800	1900	1900	2000	2000	2100	2100	2200	2200	**60**
63*	800	800	800	800	800	800	800	900	950	900	1000	1050	1150	1200	1300	1350	1450	1500	1550	1600	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	**63***
66	800	800	800	800	800	800	800	900	950	900	1000	1050	1150	1200	1300	1350	1400	1500	1550	1600	1650	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	**66**
69*	800	800	800	800	800	800	800	850	950	900	950	1050	1150	1200	1300	1350	1400	1500	1550	1600	1650	1750	1800	1850	1900	1950	2000	2050	2100	2150	2150	**69***
72	800	800	800	800	800	800	800	850	950	900	950	1050	1100	1200	1250	1350	1400	1450	1550	1600	1650	1700	1800	1850	1900	1950	2000	2050	2100	2150	2150	**72**
75*	800	800	800	800	800	800	800	850	900	900	950	1050	1100	1200	1250	1350	1400	1450	1550	1600	1650	1700	1750	1850	1900	1950	2000	2050	2100	2150	2150	**75***
78	800	800	800	800	800	800	800	850	900	850	950	1050	1100	1200	1250	1350	1400	1450	1550	1600	1650	1700	1750	1800	1900	1950	2000	2050	2100	2150	2150	**78**
81*	800	800	800	800	800	800	800	850	900	850	950	1050	1100	1200	1250	1300	1400	1450	1500	1600	1650	1700	1750	1800	1850	1950	2000	2050	2100	2100	2150	**81***
84	800	800	800	800	800	800	800	850	900	850	950	1000	1100	1150	1250	1300	1400	1450	1500	1600	1650	1700	1750	1800	1850	1900	2000	2050	2100	2100	2150	**84**
87*	800	800	800	800	800	800	800	800	900	850	950	1000	1100	1150	1250	1300	1400	1450	1500	1550	1650	1700	1750	1800	1850	1900	1950	2050	2100	2100	2150	**87***
90	800	800	800	800	800	800	800	800	900	850	950	1000	1100	1150	1250	1300	1350	1450	1500	1550	1650	1700	1750	1800	1850	1900	1950	2000	2100	2100	2150	**90**
93*	800	800	800	800	800	800	800	800	900	850	950	1000	1100	1150	1250	1300	1350	1450	1500	1550	1650	1700	1750	1800	1850	1900	1950	2000	2100	2150	2150	**93***
96	800	800	800	800	800	800	800	800	850	850	900	1000	1100	1150	1250	1300	1350	1450	1500	1550	1650	1700	1750	1800	1850	1900	1950	2000	2100	2150	2150	**96**
102	800	800	800	800	800	800	800	800	850	850	900	1000	1050	1150	1200	1300	1350	1450	1500	1550	1600	1700	1750	1800	1850	1900	1950	2000	2100	2150	2200	**102**
108	800	800	800	800	800	800	800	800	850	850	900	1000	1050	1150	1200	1300	1350	1400	1500	1550	1600	1700	1750	1800	1850	1900	1950	2000	2100	2150	2200	**108**

POSITIVE PROJECTION CONDITION — **UNLIMITED TRENCH WIDTH**

TRENCH CONDITION — **LIMITED TRENCH WIDTH - SEE NOTE 3 BELOW**

Notes:

1. The D-Load values indicated on this table are for Wall "B" RCP with Bells or Collars.
2. For intermediate cover values, use the higher D-Load of the two adjacent covers.
3. For limited trench width and for limited over-excavated trench width, refer to Tables A and B on Standard Plan S-251-1 "Pipe Laying in Trenches", respectively.
4. D-Load Calculation Data:

$$\text{D-Load} = \frac{(DL + LL)(FS)}{(D)(LF)}$$

Where:
DL = Dead load by Marston's Theory using the following values:
Soil Unit Weight (w) = 120 p.c.f;
Soil Friction Coefficient:
$K\mu'$ = 0.15 for trench condition;
$K\mu$ = 0.19 for positive projection condition;
Settlement Ratio (r_{sd}) = 0.7
LL = Live load - AASHTO - HS20-44 (Highway Loading)
FS = Factor of Safety = 1.5
D = Inside diameter of pipe in feet
LF = Load Factor = 2.7 (Refer to Standard Plan S-251-1 "Pipe Laying in Trenches")

5. If soil tests indicate that the soil unit weight is greater than 120 pounds per cubic foot, increase the D-Load accordingly.
6. For pipe sizes greater than 108", covers greater than 30', railroad loading, heavy construction loads, or loading due to ground water, consult the Structural Engineering Division.

*** Intermediate pipe sizes are only available through special order.**

D-Loads For Reinforced Concrete Pipe with Bells, Case III Bedding
Figure F490.2.C3B