Installation Guide

SEWER/STORM DRAIN

PERMA-LOC

building essentials for a better tomorrow™

JMM

⚠ WARNING

RUPTURE HAZARD

IMPROPER INSTALLATION OR MISUSE OF TAPPING TOOLS MAY CAUSE PIPES UNDER HIGH PRESSURE TO RUPTURE AND RESULT IN HIGH VELOCITY AIRBORNE FRAGMENTATION LEADING TO SERIOUS INJURIES AND/OR DEATH.

- BEFORE AND DURING INSTALLATION, ALWAYS:
  - Consult and follow the FULL VERSION of the product installation guide
  - Closely follow job specifications
  - Use protective gear and equipment

- BEFORE AND DURING TAPPING, ALWAYS:
  - Consult and follow JMM Publication TR-410A "Pressure Pipe Tapping Guide"
  - Use the correct tapping tools
  - Bleed air from pipes at high spot before tapping
  - Use protective gear and equipment

Please contact JMM Product Assurance at (800) 621-4404 to obtain full version of the appropriate installation guide or for further assistance.

Table of Contents

The physical (or chemical) properties of JMM PVC Perma-Loc Gravity Sewer pipe presented in this booklet, represent typical average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Check with JMM Product Assurance to ensure current information.

How This Guide Can Help You

This booklet was written especially for the installer and those who direct the actual handling and installation of JMM PVC Perma-Loc Gravity Sewer Pipe. This guide should be used in conjunction with the following industry accepted installation and testing practices which are applicable. This document should not be considered a full guide or manual in lieu of:

1) ASTM D 2774-01 (or later) "Underground Installation of Thermoplastic Pressure Piping."
2) ASTM F 690-86 (1994) (or later) "Underground Installation of Thermoplastic Pressure Piping Irrigation Systems."
3) ASTM F 1668-96 (2002) (or later) "Construction of Buried Plastic Pipe."
4) ASTM F 645-02 (or later) "Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems."
5) ASTM D 2321-00 (or later) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications."
6) ASTM F 1417-92 (or later) "Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air."
7) AWWA C605 "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water."
8) AWWA C651 "Disinfecting Water Mains."

9) AWWA M 23 "PVC Pipe – Design and Installation."
10) Uni-Bell PUB-09 "Installation Guide for PVC Pressure Pipe."
11) Uni-Bell UNI-B-6 "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe."
12) Uni-Bell UNI-PUB-06 "Installation Guide for PVC Solid-Wall Sewer Pipe (4-15 inch)."
13) Uni-Bell UNI-TR-1 "Deflection: The Pipe/Soil Mechanism."
14) Uni-Bell UNI-TR-6 "PVC Force Main Design."
15) Uni-Bell UNI-TR-7 "Thermoplastic Pressure Pipe Design and Selection."

This guide is meant as an explanatory supplement to the materials above on how to install JMM PVC Perma-Loc Gravity Sewer pipe under normal or average conditions so as to comply with Standard JMM Laying Specifications. Any discrepancies between the above standards and the written information contained herein, should be brought to the attention of JMM Product Assurance immediately for resolution by JMM, prior to any actions by either contractor, engineer, or municipality.

This guide is not intended to supply design information nor to assume the responsibility of the engineer (or other customer representative) in establishing procedures best suited to individual job conditions so as to attain satisfactory performance.

Engineers, superintendents, contractors, foremen, and laying crews will find much to guide them in the following specifications. This booklet will also be of help in determining pipe needs when ordering.

Warranty

J-M Manufacturing Company, Inc. (JMM) warrants that its standard polyvinyl chloride (PVC), polyethylene (PE), conduit/plumbing/solvent weld and Acrylonitrile-Butadiene-Styrene (ABS) pipe products ("Products") are manufactured in accordance with applicable industry specifications referenced on the Product and are free from defects in workmanship and materials. Every claim under this warranty shall be void unless in writing and received by JMM within thirty (30) days of the date the defect was discovered, and within one (1) year of the date of shipment from the JMM plant. Claims for Product appearance defects, such as sun-bleached pipe etc., however, must be made within thirty (30) days of the date of the shipment from the JMM plant. This warranty specifically excludes any Products allowed to become sun-bleached after shipment from the JMM plant. Proof of purchase with the date thereof must be presented to the satisfaction of JMM, with any claim made pursuant to this warranty. JMM must first be given an opportunity to inspect the alleged defective Products in order to determine if it meets applicable industry standards, if the handling and installation have been satisfactorily performed in accordance with JMM recommended practices and if operating conditions are within standards. Written permission and/or a Return Goods Authorization (RGA) must be obtained along with instructions for return shipment to JMM of any Products claimed to be defective.

The limited and exclusive remedy for breach of this Limited Warranty shall be, at JMM's sole discretion, the replacement of the same type, size and like quantity of non-defective Product, or credits, offsets, or combination of thereof, for the wholesale purchase price of the defective unit.

This Limited Warranty does not apply for any Product failures caused by user's flawed designs or specifications, unsatisfactory applications, improper installations, use in conjunction with incompatible materials, contact with aggressive chemical agents, freezing or overheating of

liquids in the product and any other misuse causes not listed here. This limited warranty also excludes failure or damage caused by fire stopping materials, tread sealants, plasticized vinyl products or damage caused by the fault or negligence of anyone other than JMM, or any other act or event beyond the control of JMM.

JMM's liability shall not, at any time, exceed the actual wholesale purchase price of the Product. The warranties in this document are the only warranties applicable to the product and there are no other warranties, expressed or implied. This limited warranty specifically excludes any liability for general damages, consequential or incidental damages, including without limitation, costs incurred from removal, reinstallation, or other expenses resulting from any defect. IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY DISCLAIMED AND JMM SHALL NOT BE LIABLE IN THIS RESPECT NOTWITHSTANDING JMM's ACTUAL KNOWLEDGE THE PRODUCT'S INTENDED USE.

JMM's Products should be used in accordance with standards set forth by local plumbing and building laws, codes, or regulations and the applicable standards. Failure to adhere to these standards shall void this Limited Warranty. Products sold by JMM that are manufactured by others are warranted only to the extent and limits of the warranty of the manufacturer. No statement, conduct or description by JMM or its representative, in addition to or beyond this Limited Warranty, shall constitute a warranty. This Limited Warranty may only be modified in writing signed by an officer of JMM.

1.0 Receiving and Handling Pipe Shipments

JMM Figure 1

1.1 Inspection

Each pipe shipment shall be inspected with care upon arrival. Each pipe shipment is carefully loaded at the factory using methods acceptable to the carrier. The carrier is then responsible for delivering the pipe as received from JMM. All shipments include an adequate amount of lubricant for the pipe and a short form installation guide. IT IS THE RESPONSIBILTY OF THE RECEIVER TO MAKE CERTAIN THERE HAS BEEN NO LOSS OR DAMAGE (including smoke) UPON ARRIVAL.

Check the materials, pipe, gaskets, and fittings received against the bill of lading (tally sheet that accompanies every shipment) in accordance with the general guidelines below, reporting any error or damage to the transportation company representative and have proper notation made on the delivery receipt and signed by the driver. Present the claim in accordance with the carrier's instructions. Do not dispose of any damaged material. The carrier will advise you of the procedure to follow in order to procure samples and report the incident.

1. MAKE OVERALL EXAMINATION OF THE LOAD. If the load is intact, ordinary inspection while unloading should be enough to make sure pipe has arrived in good condition.
2. IF LOAD HAS SHIFTED OR SHOWS ROUGH TREATMENT, THEN EACH PIECE MUST BE CAREFULLY INSPECTED FOR DAMAGE.
3. CHECK THE TOTAL QUANTITIES OF EACH ITEM AGAINST THE TALLY SHEET (pipe, fittings, lubricant, etc.)
4. ANY DAMAGED OR MISSING ITEMS MUST BE NOTED ON THE DELIVERY RECEIPT AND RETURNED TO THE TRANSPORTATION COMPANY.
5. NOTIFY CARRIER IMMEDIATELY AND MAKE CLAIM IN ACCORDANCE WITH THEIR INSTRUCTIONS.
6. DO NOT DISPOSE OF ANY DAMAGED MATERIAL. Carrier will notify you of the procedure to follow.
7. SHORTAGES AND DAMAGED MATERIALS ARE NOT AUTOMATICALLY RESHIPPED. If replacement material is needed, reorder through your distributor and make them aware of the claim.

NOTICE: Inspect the vertical ribs of the pipe during unloading and handling for damage that may occur due to over tightening of the tie-downs. A maximum of eight (8) adjacent ribs can be missing without affecting performance. Ensure that the wall beneath the broken ribs is not cracked. Table 1 lists the maximum circumferential length of missing ribs by size that should not be exceeded.

JMM Table 1

Pipe Size (in)	Max Length (in)	Pipe Size (in)	Max Length (in)
18	15	30	10
21	14	36	10
24	12	42	10
27	10	48	9

1.2 Unloading

JMM Figure 2

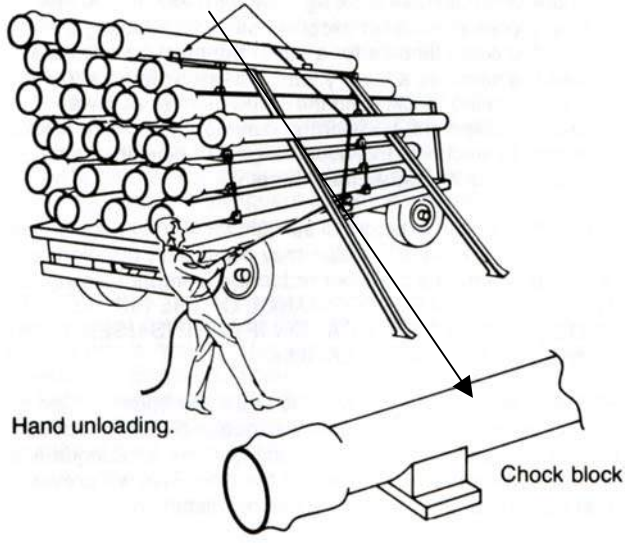
JMM PVC Perma-Loc Gravity Sewer pipe is lightweight and may be unloaded by 1) Hand, either by passing over the side or off the truck ends. Sliding one length on another is standard practice in unloading PVC pipe, but may damage to ribs of the pipe should be avoided. All lengths in the load should be lifted off of the rough surface of the pipe and truck body to avoid abrasion. 2) Compact shipping units (palletized bundles in a wood frame) are used to ship large orders of pipe. Conventional forklifts can unload these units quickly and easily. Care shall be exercised to avoid impact or contact between the forks and the pipe. The means by which JMM PVC Perma-Loc Gravity Sewer pipe is unloaded in the field is the decision and responsibility of the customer. Preferred unloading is in units using mechanical equipment such as forklifts, cherry pickers, or front-end loaders with adequate forks and trained, competent operators. When unloading units, the following instructions should be carefully followed. Remove only one row at a time.

1) Remove restraints from the top unit loads. These may be either tie down straps, ropes, or chains with protection.

2) If there are 1" x 4" boards across the top and down the sides of the units, remove all of them.
3) Use a forklift (or front-end loader equipped with forks) to remove each top row one at a time from the truck. The forklift can take only part of one row at each lift. The fork arms are inserted under the row between the horizontal separation pieces. Roll the remaining pipe in the row to the chocks on the unloading side preparatory for next lift. Remove back rows first. Do not run the forks too far under the unit as fork ends striking adjacent units may cause damage. Do not let forks rub the underside of pipe to avoid abrasion. If the pipe truck is tilted away from the forklift, the pipe furthest from the forklift could fall off of the row. Therefore, roll the pipe towards the forklift as a row is unloaded, keeping the pipe balanced on the dunnage.
4) If a forklift is not available, a spreader bar on top and nylon strips capable of handling the load, spaced approximately eight (8) feet apart looped under the unit may be used. Cables may also be cushioned with a rubber hose sleeve or other material to prevent abrasion of the pipe.
5) During the removal and handling be sure that the units do not strike anything. Severe impact could damage the pipe (particularly during cold weather).
6) DO NOT:
    a) Handle units with chains or single cables.
    b) Attach cables to unit frames for lifting.
7) Units should be stored and placed on level ground. Units should be protected by dunnage in the same way they were protected while loaded on the truck. The dunnage must support the weight of all units so that pipe lengths do not carry the weight of the unit loaded above them. Units should not be stacked more than two (2) high.
8) To unload lower units, repeat the above unloading process (items 1 through 7).

If unloading equipment is not available, pipe may be unloaded by removing individual pipe and cutting the bands that secure the top tiers to the tiers below. However, care should be taken to ensure that pipe is not dropped or damaged. For guidance in unloading by hand, the weights of individual lengths of pipe may be derived from the values presented in the appropriate
JMM Product Brochure under the Short Form Specification.

Warning: PVC pipe, though lighter than other material, is still heavy and may be dangerous if not handled properly. Not adhering to the above instructions may result in serious injury to pipe, property, and/or persons. Do not stand or climb on units. Stand clear of pipe during unloading.



JMM Figure 3

NOTICE: Pipe at the bottom of a stack may become out-of-round due to the weight of material above it. At normal application temperatures this corrects itself soon after the load is removed due to the property of elastic memory. Under freezing conditions this recovery to full initial roundness may take several hours.

1.3 Cold Weather Handling

As the temperature approaches and drops below freezing, the flexibility and impact resistance of PVC pipe is reduced. Extra care should be used in handling during cold weather to avoid any type of impact to the pipe to prevent damage.

1.4 Stockpiles

Store pipe on a flat surface so as to support the barrel evenly, with bell ends overhanging. If mechanical equipment is being used for handling, the unit bearing pieces provide an excellent base. If unloading by hand, secure two timbers for a base. Set them on a flat area spaced the same as a factory load. Nail chock blocks at each end. Build up the stockpile in the same manner, as it was stacked for shipment, transferring dunnage and chock blocks from load to stockpile. Store random lengths separately where they will be readily available. Units should not be stacked more than 2 units high and individual lengths of pipe should be stacked in piles no higher than five (5) feet.

It should be noted that when PVC pipe is stored outside and exposed to prolonged periods of sunlight, an obvious discoloration of pipe could occur. This discoloration may be an indication of a reduction in pipe impact strength. Pipe possessing discoloration should be handled with care during installation. **This discoloration is a surface layer of hardened plastic and does not inhibit the long-term properties and performance of the pipe if it is handled properly during installation.** This degradation does not continue after the pipe is removed from UV exposure.

A method of protecting pipe during long exposures (several months) to sunlight is to cover it with canvas or other opaque material. Clear plastic sheets are not satisfactory. Allow for adequate air circulation between the cover and the pipe. This will prevent heat build-up and possible dimensional distortion.

1.5 Gasket Care

Keep gaskets clean, away from oil, grease, excessive heat and electric motors, which produce ozone. It is advisable to keep gaskets protected from direct sunlight and temperature changes to avoid cracking in prolonged exposure for optimal performance. JMM provides a standard gasket that is approved for sewer service with its standard product. Special gasket types may be available for applications where oil resistance is required. Be sure the correct ring is ordered. See Section 3.4 for further information.

1.6 Loading Transfer Trucks

Use trucks with long bodies so that pipe lengths do not over hang more than two (2) feet. Make certain truck bed is smooth, without cross-strips, bolt heads, or other protrusions that could damage the pipe.

Place the first layer carefully with the bell ends overhanging. Avoid sliding the pipe and abrading it. Subsequent layers can be put into place. All bell ends should overhang the layer below.

Short body trucks may be used if fitted with racks that properly support the pipe in the horizontal position. The rack shall support the pipe with supports spaced every three (3) feet or less along the pipe lengths. Pad the contact areas to avoid damage to the pipe.

1.7 Distributing Along the Trench

In stringing out pipe, keep these points in mind:

1. Line pipe as near to the trench as possible to avoid excessive handling. (Bell direction doesn't affect flow or hydraulic coefficients.)
2. If the trench is open, it is advisable to string pipe on the side away from excavated earth wherever possible, so that the pipe can be moved easily

to the edge of the trench for lowering into position.

3. If the trench is not yet open, find out which side the excavated earth will be thrown; then string out on the opposite side (leave room for the excavator).
4. Place the pipe so as to protect it from traffic and heavy equipment. Also, safeguard it from the effect of any blasting that may be done.

2.0 Trench Construction

2.1 Working Ahead of the Pipe Laying Crew

Where soil and ground water conditions permit, long stretches of trench can be opened ahead of pipe laying, so as to take full advantage of the easy handling and speed of assembly of JMM PVC Perma-Loc Gravity Sewer Pipe with elastomeric joints. However, as a general rule for most jobs, do not open the trench too far ahead of pipe laying. Avoiding these long stretches of opened trench may help with the economy of the project because:

1) It may reduce or even eliminate pumping or sheeting.
2) It minimizes the possibility of flooding the trench.
3) It reduces caving caused by ground water.
4) It helps avoid frozen trench bottom and backfill.
5) It reduces hazards to traffic and workmen.

On most jobs it will be desirable to keep excavating, pipe laying, and backfilling close together.

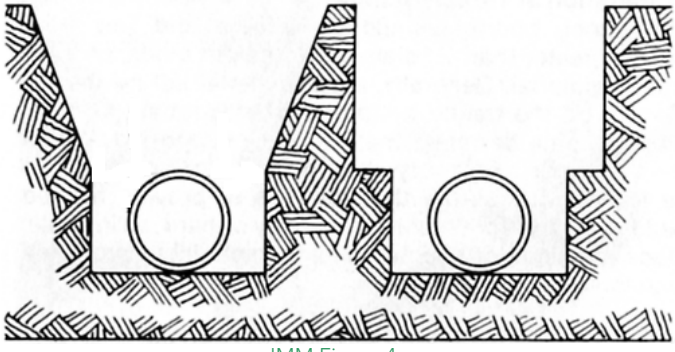
2.2 Curves in the Trench

The trench may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe as described below. Since the moment of inertia of Perma-Loc pipe is high, attempting to curve the pipe is extremely difficult. If the pipe barrel cannot be curved, the joints may be deflected to a maximum of 3 degrees (or approximately an 8 inch offset* maximum). *Offset is based on a 13 ft length of pipe. To accomplish this, the pipe should be assembled in straight alignment and then, with the joint

braced, the free end moved laterally using a pry bar or other suitable means. Care should be taken not to exceed the maximum deflection allowed or damage the pipe with the machinery used. The line may be assembled above ground, in a straight line, and then curved when laid in the trench, if necessary. Abrupt changes in direction may be accomplished with fittings.

NOTICE: AVOID OVER-STRESSING THE BELL (over-inserting the joints, or exceeding the maximum deflection allowed) IN ORDER TO PREVENT POSSIBLE BREAKAGE AND/OR LEAKS.

2.3 Trench Widths



JMM Figure 4

Since JMM PVC Perma-Loc Gravity Sewer pipe can be assembled above ground and lowered into position, trench widths can be kept to a minimum. The trench width at the ground surface may vary with and depend upon depth, type of soils, and position of surface structures. The minimum clear width of the trench, sheeted or unsheeted, measured at the spring-line of the pipe should be one foot greater than the outside diameter of the pipe. The maximum clear width of the trench at the top of the pipe should not exceed a width equal to the pipe outside diameter plus two (2) feet. This spacing will allow for proper compacting of the backfill to provide necessary sidewall support. It will also allow

assembly work in the trench, if desired. If the above defined trench widths must be exceeded or if the pipe is installed in a compacted embankment, pipe embedment should be compacted to a point of at least 2.5 pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

NOTICE: Since PVC is a flexible pipe, trench width and shape have little to no effect on loading experienced by the pipe, since the maximum load that may be carried by the pipe is that due to the column of soil directly above the pipe outside diameter. The reason for the trench width recommendations above are to help installers realize the economies that may result from installation of PVC pipe over other materials, while maintaining adequate control over backfilling, compaction, and placement to limit long-term deflection.

2.4 Trench Depths

Surface loads, earth loads, and frost penetration govern depth. A minimum of 12 inches depth of cover is recommended where frost penetration need not be considered. Where frost is a factor, pipe should be buried 6 inches below the greatest recorded frost penetration. If the line will be drained and not used in winter, frost need not be considered.

Should unusual soil conditions and/or surface loads be anticipated and the engineer wants to calculate deflection when working with PVC pipes, "pipe stiffness" ($f/\Delta y$) for ASTM F 794 pipe is 10 psi and 46 psi for T10 and T46 pipe (all sizes), respectively. AASHTO M304 "pipe stiffness" numbers vary by size and the standard should be consulted for these values.

For more information on deflection, see Section 5.1.

2.5 Preparation of Trench Bottom

The trench bottom should be smooth and free from stones greater than 1.5 inches in diameter, large dirt clods, and any frozen material. Excavation at bells (bell holes) should be provided so that the pipe is uniformly supported along its length.

JMM Figure 5

Generally, loose material left by the excavator on the trench bottom will be adequate for bedding the pipe barrel so that it is fully supported. Where the excavator cuts a very clean bottom, soft material can be shaved down from the sidewalls to provide needed bedding. If the trench bottom is rocky or hard, as in shale, place a 4-inch layer of selected backfill material to provide a cushion for the pipe. In rock excavation it is necessary that rock be removed and a bed of sand or selected backfill at least 4 inches deep be placed on the bottom of the trench to provide a cushion for the pipe. A pipeline of any material, which in the absence of a bedding cushion, resting directly on rock is subject to breakage under the weight of the backfill load, surface load, or earth movements.

When an unstable trench bottom is encountered and, in the opinion of the engineer, it cannot support the pipe, an additional depth should be excavated and refilled to the pipe grade with material approved by the engineer.

Trenches can be dangerous and the contractor has the responsibility of ensuring that all safety regulations and design requirements have been observed for the protection of the workers and the public.

2.6 Casings

2.6.1 Placement of Casings

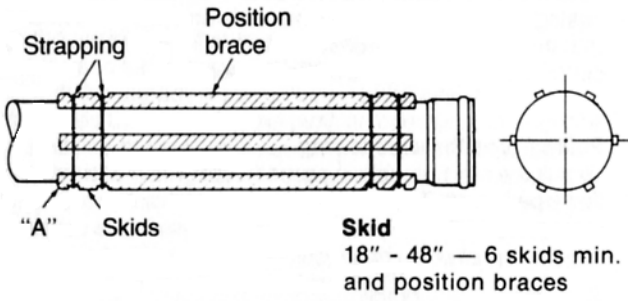
The placement of casings requires special equipment and skills. It is a specialized field of construction, to which some construction firms devote their entire efforts.

In the smaller diameters, the steel casing is usually placed progressively, following the boring equipment as it tunnels through the obstruction. The recommended practice is to use plain steel pipe (not corrugated) for the casing to facilitate movement of the PVC pipe through the casing with a minimum of resistance. For larger diameters, most casing construction is done by jacking the pipe from excavated pits. Where long casings are involved, numerous pits for jacking operations are required along the route.

Regardless of the diameter, accuracy in alignment and grade of the casing pipe is very important in maintaining the established inverts. Proper grade of the inserted pipe is a must for satisfactory operation of a gravity flow line.

2.6.2 Pulling the Pipe

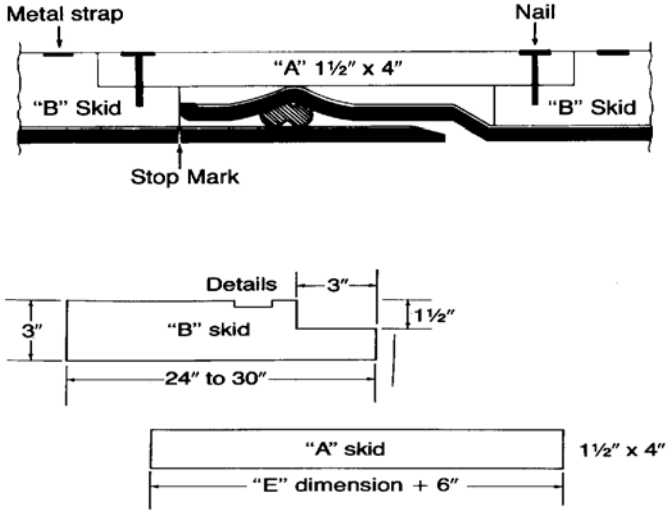
When PVC pipe is to be installed in casings under highways or railroad tracks, skids with rounded ends must be used to prevent the pipe and bells from snagging on the inside of the casing, and to keep the installed line from resting on the bells of the pipe. Skids shall be thick enough to allow clearance between the bells and the casing bottom. For pipe larger than 18 inches, six (6) skids should be placed at 60 degrees around the pipe.



JMM Figure 6

A cable is passed through the casing and the first pipe length is fastened to a suitable wood crosspiece at the end of the pipe. The cable is then pulled steadily by a winch, tractor, or other method until about two (2) feet of pipe is left projecting out of the casing for assembly of the next length. (If cable is pulled at an angle, make sure that the leading pipe end is protected from damage.) The cable is then passed through the next pipe and the two pipes are assembled. This operation is continued until the pipe is completely through the casing.

NOTICE: In order to prevent over-insertion of the pipe joint while installing it through casings, some method of restricting the movement between the assembled bell and spigot must be provided. Four such assemblies should be made at 90 degree spacing around the pipe bells. All "B" Skids must be tightly strapped to the pipe by metal strapping or similar material. Also, note that all skids should be notched and leveled so that they form a smooth, flat bottom. This is necessary so that no portion of the pipe is carrying the total load. An illustration of one proposed method is shown in Figure 7.



JMM Figure 7

The inserted PVC pipelines should be circumferentially braced in the casing to prevent movement in any direction. In force sewer mains, movement can be caused by the thrust action generated by a slightly deflected joint. For gravity flow lines, movement of the inserted pipe may be caused by floatation from flooding of the annular spaces at each end of the casing. It is recommended that these spaces be sealed as described in Section 2.6.3.

In some cases, small pipe in larger casings may require skids or positioning braces placed around the entire circumference of the pipe to keep the pipe in proper alignment in the casing. When pipe is pulled into a casing with a cable, the pipe may rotate, causing the skids and positioning braces to rotate from their entry position. Consequently, if a sufficient number, size, and circumferential spacing of skids and braces are not employed, the bells cannot be kept from contacting the casing surfaces. Lubricating the casing or skids will make sliding entire circumference easier. Depositing drilling mud

or flax soap at the end of the casing can lubricate the casing. Then attach rags to the cable and pull them through so that they act as swabs or spreaders. A rope attached to the cable will make it easy to retrieve. Petroleum products, such as oil and grease, should not be used as lubricants since prolonged exposure to these products is detrimental to the rubber gaskets used to seal the joints.

PVC pipe may also be pushed through the casing, using equipment, which will exert a constant and uniform force against the pipe end. To accomplish this, the pushing equipment must be firmly anchored and the joints sufficiently braced.

2.6.3 Closure of Casing After Pipe Installation

Under no circumstances should the ends of the casing be closed or any material installed inside the casing until the completion of all testing and approved by the engineer. After testing, the ends of the casing should be sealed off.

A generally accepted practice is to sack the end of the casing, leaving an opening on the bottom. Sacking is to be placed between the PVC pipe and the casing except that the areas at the bottom between the skids are to be left open. This will keep backfill out of the casing, while allowing for drainage.

The casing should not be backfilled with sand unless specified by the engineer. When sand is used, drainage is obstructed and access to the interior of the casing is made more difficult. Also, if the sand is packed tightly, the load on the casing may be transferred to the PVC pipe, thus nullifying the purpose of the casing. Where backfilling of the annular space under and around the encased pipe is required, ¾ of the distance to the top of the casing should be filled with sand or other approved material. Again, the areas between the skids (under the pipe) should be left open for drainage. When using a hose line, sand can be forced into the casing with water under pressure. Care must be

taken to avoid forcing too much water into the casing because of the possibility of floating the pipe. Floatation could result in uneven support for the encased pipeline if the skid system fails to prevent movement in all directions.

NOTICE: Under no circumstances should any blocks or spacers be wedged between the pipe and the top of the casing.

Pressure grouting, when not strictly controlled, can collapse PVC pipe. Pressure grouting is sometimes specified for filling in the annular space between the pipeline and the casing.

If pressure grouting is to be utilized, it will be necessary to arrange the skids and position braces on the pipe so as to accommodate a two (2) inch grouting hose. The recommended pressure grouting method is as follows:

1. Arrange the skids and position braces on the pipe as shown in Figure 6. They will accommodate the grouting hose.
2. Secure the grouting hose to the leading end of the first pipe section before insertion begins.
3. Either push or pull the pipe into the casing, channeling the hose in place on the leading end of each succeeding section of pipe.
4. Cap or plug each end of the bore, leaving an air hole at the top of the low end and a hole at the top of the high end for the grouting hose to pass through.

Use a grout mixture in a ratio of four (4) parts cement to one (1) part sand, with sufficient water to yield a consistency of thick soup.

Start pumping very slowly. A sensitive pressure gauge should be mounted on the discharge outlet of the grouting machine. A pressure will develop equal to pressure needed to deliver the grout through the hose. After this pressure is

established, any increase in pressure by 2 or 3 psi will indicate a need to pull the grouting hose slightly until the pressure returns to the established average delivery pressure. It is essential that the pressure generated does not exceed 2 or 3 psi over the initial required delivery pressure. Continue this procedure until the bore is ¾ of the way full.

NOTICE: Wooden skids in backfill should have a long life. The life of the skids will be further extended if they are treated before backfilling. If there is to be no backfill, it is important that the skids be treated with a wood preservative. Functionally, it is not necessary to backfill around the pipe inside the casing with sand or any other material.

3.0 Pipeline Construction

3.1 Inspection

Pipe and accessories should be inspected for defects and cleanliness prior to lowering into the trench. Any defective, damaged, or unsound material should be repaired or replaced and foreign matter or dirt should be removed from the interior of the pipe and accessories before lowering into the trench.

3.2 Lowering Pipe and Accessories into Trench

All pipe, fittings, valves, and accessories should be carefully lowered into the trench using suitable equipment in such a manner as to prevent damage to pipe and accessories. PIPE AND ACCESSORIES SHOULD NEVER BE DROPPED OR DUMPED INTO THE TRENCH.

Caution: Heavy impact may cause a slight longitudinal indentation in the outside of the pipe or break ribs and create a crack on the inside. This will result in a split as soon as the pipe is placed under loading. Any pipe that has been impacted should be examined closely for this type of damage.

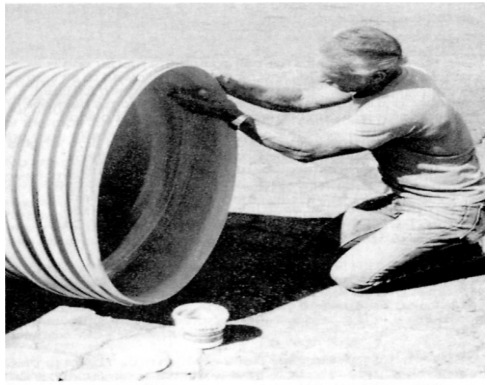
3.3 Assembly of JMM PVC Perma-Loc Pipe

The Perma-Loc joint assembly is a push-on assembly in which the lubricated bell end is inserted over the rubber gasket and onto the spigot as described in this installation guide. The gasketed joint assembly provides for the completion of tight, dependable joints in minimum time when the following procedure is adhered to.

3.4 Assembly Instructions

JMM supplies a standard gasket for normal service with its sewer products and an oil resistant gasket under special request. The correct gasket for normal service is not marked with any identifiers. The oil resistant gasket for special services has a blue band on the visible gasket face. Be sure you have the correct gasket for the installation. If you require oil resistant gaskets and those provided are for normal service, then contact JMM immediately. Do not use the normal service gaskets when oil resistance is required. Note that either ring type may be used for conveying sewage.

1. Make certain that the spigot, gasket, and bell are clean, with no dirt or foreign material that could interfere with proper seating of the gasket or assembly. If necessary, wipe the gasket and bell with a clean, dry cloth. Lubricating the gasket is not recommended. Remove protective covering from rings before use.
2. Make sure pipe end is clean. Wipe with a clean dry cloth around the entire circumference from the end to one inch beyond the reference mark.



JMM Figure 8

3. Lubricate the inside of the bell end of the pipe, using only the JMM Ring-Tite lubricant (NSF approved) supplied. Be sure to cover the entire bell end circumference. The coating should be the equivalent of a brush coat of enamel paint. Lubricant can be applied to the pipe by hand, cloth, pad, sponge, or glove. Lubrication of the gasket and/or ring groove may result in displacement during assembly.

Caution: After bell end is lubricated, do not allow it to contact the bedding material. Small pieces of stone or soil may adhere to the lubricant and may become lodged between the spigot and the gasket upon assembly, resulting in a possible leak.

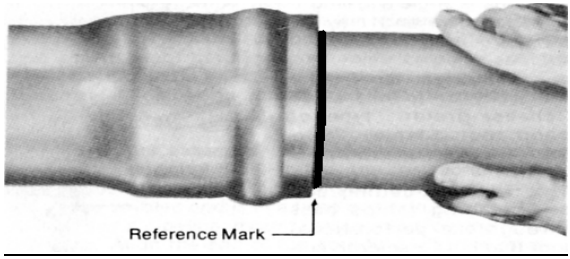
NOTICE: JMM Ring-Tite lubricant has been tested and approved for sewer service. Do not use non-approved lubricant, which may harbor bacteria or damage the gaskets.

4. Insert the beveled spigot end into the bell so that it is in contact with the gasket and keep the lengths in proper alignment. The pipe can be allowed to sit in this position while the puller or come-a-long is attached for final assembly. Brace the bell, while the

spigot end gasket is inserted, so that previously completed joints in the line will not be closed up or over-assembled. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell. Stabbing is not recommended and should be avoided to prevent damage to the gasket and joint.

JMM Figure 9

Caution: If joint is over-assembled causing the spigot to jam into the neck of the bell, flexibility of the joint is lost. Uneven settlement of the trench or additional loading may cause this type of joint assembly to leak or crack. Do not assemble beyond the reference mark.



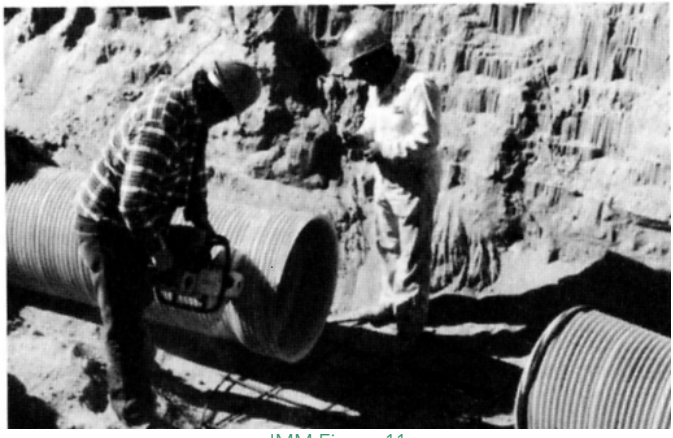
JMM Figure 10

If undue resistance to insertion of the beveled end is encountered or the reference mark does not reach the flush position, disassemble the joint, and check the position of the gasket. If it is twisted or pushed out of its seat, realign the gasket and repeat the assembly steps. Be sure both lengths are in proper alignment. If the gasket was not out of position, measure the distance between the reference mark and the bevel end. This measurement should be seven (7) inches. Relocate the reference mark if it is out of position. Accurate reference mark location is required to avoid over-insertion issues and joint leakage.

NOTICE: Should a spigot or bell end become deformed under load at higher temperatures, it will be necessary to exercise more care in assembling the joint in order to prevent fish-mouthing of the gasket.

3.5 Cutting

A square cut is essential to ensure proper assembly and/or beveling of spiral profile pipe. JMM PVC Perma-Loc Gravity Sewer pipe can easily be cut with builder's saw or abrasive disc. To prepare for cutting the pipe, it is recommended that the pipe be marked completely around the circumference. Be sure the measuring tape is perpendicular to the axis of the pipe. After marking is completed, place masking tape around the pipe on the marking to serve as a cutting guide. After pipe is cut and a new ring groove has been routed, remember to place a new reference mark seven (7) inches from the pipe end. Do not burn the pipe while cutting and routing.



JMM Figure 11

3.6 Beveling

Use a factory-finished beveled end as a guide to determine the angle and length of taper, if required. The end may be beveled using a plastic pipe-beveling tool as shown, which will cut the correct taper automatically or such tools as the Stanley "Surform" No. 399, a coarse file, or rasp. A portable sander or abrasive disc may also be used to bevel the pipe end. Remove all burrs and raised edges prior to assembly. Care must be exercised to prevent injury when working with Perma-Loc after cutting and before beveling. It is recommended that heavy work gloves be worn when handling this pipe.

3.7 Locating Reference Mark

With a pencil, crayon, or permanent marker, locate the reference mark at the proper distance from the beveled end as indicated in Section 3.4. The reference mark may also be located accurately by using a factory-marked end of the same pipe as a guide.

3.8 Assembly at Fittings and Adaptors

JMM PVC Perma-Loc Gravity Sewer pipe is manufactured in accordance with ASTM F 679 and/or AASHTO M304

standards and is adaptable to most all existing standard sewer products and fittings.

No extra support need be provided for these fittings and adaptors, but any heavy metal fittings or valves must be individually supported to avoid differential settlement between fittings and pipe.

Fittings and adaptors are usually installed at predetermined locations and therefore, a tie-in length less than the standard pipe length will usually be required.

NOTICE: If a pry-bar, or backhoe is used for any assembly, a wood plank should be placed between the pipe and the machine to prevent damage. In addition, the force applied must be steady and constant. Do not ram or hit the pipe. For all pipe, a come-a-long jack is recommended over a backhoe. The method of attachment to the pipe must not abrade or damage the pipe in any way. Steps must be taken during installation using these methods to maintain correct alignment of the pipe. In addition, a helper should be present in all cases to assist the operator in knowing when the reference mark is reached properly.

3.9 Anchorage of Pipe on Slopes

Anchors on slopes are needed only when there is the possibility of backfill slipping downhill and carrying the pipe with it. Usually, well-drained soil, carefully tamped in four (4) inch layers up to the top of the trench, will not slide and pipe anchors will not be required.

Where soil slippage is a possibility, anchors keyed in undisturbed soil can be fastened to every other length of pipe.

3.10 Service Connections

Service connections may be made to JMM PVC Perma-Loc Gravity Sewer pipe by means of various fittings and saddles. When using fully gasketed fittings, please follow the

standard assembly instructions outlined in Section 3. When using epoxy-welded fittings, please refer to the fitting manufacturer's instructions for more detail. For the application of sewer saddles, please adhere to the instructions below in amendment to Section 3 and the fitting manufacturer's instructions.

3.10.1 Making Epoxy Weld Saddle Connections.

You will need: PVC tee or wye, primer and epoxy resin, and saddle clamps (optional). In addition the following tools will be required: shell cutter or saber saw, brace and bit, strap tensioning and crimping tools, and brushes or daubers for epoxy.

1. Place the saddle in position on the pipe and mark a guideline for the hole cut-in, using the saddle hole as a template. Remove the saddle from the pipe.
2. Using the hole guide mark, cut the hole through the pipe wall ½" outside the hole guide mark. For most saber saws with heavy-duty blades, the blade should be held horizontally across the pipe and pressed downward until it penetrates the pipe wall. Then the blade can be brought to the vertical position and the hole cut completed.

NOTICE: Tool manufacturer's instructions and safety precautions must be followed to ensure the safety of workers.

3. Wipe clean and dry both the underside of the saddle and the mating surface of the pipe. Check the fit. If it doesn't properly fit down through the ribs to the pipe wall, trim the bottom projection to the appropriate contour mark and/or trim the hole and saddle until the fit is satisfactory.
4. Thoroughly mix the two epoxy parts. Apply the mixture generously around the pipe hole between each rib, and fill the bottom groove of the saddle.

Use a second epoxy kit if there isn't enough to adequately fill these areas.

5. Immediately position the saddle over the hole in the pipe. Fit the saddle into the hole and push any excess epoxy up into the sealing area. Use saddle clamps if required. The saddle must not be moved once it makes contact with the pipe for a minimum of 15 minutes. Make remaining connections.
6. Backfill should be carefully selected and tamped around the pipe and saddle to provide firm and continuous support for both.

Warning: Keep epoxy away from flame or excessive heat to avoid combustion or explosion. In addition, when assembling saddles onto pipe, toxic fumes are given off. In confined areas sufficient concentrations of these fumes may accumulate to cause nausea and/or dizziness.

To prevent toxic fume build-up, it is recommended that:

1. Saddles be installed above ground where possible or in areas with good air circulation.
2. In confined areas with poor natural circulation, a blower should be used.
3. If the above installation environmental conditions are not practical or possible, respirators should be used. Respirators approved under the Bureau of Mines Schedule 23 as manufactured by MSA, American Optical Corp, Welsh Mfg., etc. for protection against organic vapors have been found to be satisfactory.

3.10.2 Additional Comments on Cut-ins

In summary, certain precautions should be taken when making a field cut-in connection. Every effort should be made to prevent the entrance of foreign matter into the pipe opening during assembly of the sewer saddle and before connection is completed to sewer stub pipe or the saddle inlet has been capped or plugged, should the stub pipe be connected later. Likewise, the sewer stub pipe should be

capped or plugged at its terminating point where the house sewer line is to be installed later.

In the past, field cut-in connections for future house service lines were seldom made during initial sewer construction. Their use has been largely limited to installed sewer lines in undeveloped areas, where plugged or capped fittings were not provided for this purpose when the sewer was originally laid.

In recent years, however, this practice has changed and there is a marked increase in many areas where field cut-in connections are now provided during the initial service line installation. This change can be attributed to changing requirements by the sewer system authorities.

3.11 Manholes and Rigid Structures

Sewer systems require various sizes and types of manholes for two reasons:

1. To provide access to sewer lines for inspection and maintenance.
2. To provide for changes in sewer direction and elevation.

By design practice, sewer mains are usually constructed in straight lines between manholes, which are located at points where directional changes are required. Drop manholes are used to provide for significant changes in grade or elevation due to topography of the area. In addition, manholes are generally placed at intervals of 300 to 400 ft in sewer collecting lines. This distance varies with localities, engineers, and sanitary engineering standards. The use of curved sewers, particularly in some West Coast areas, has made it possible to reduce the number of manholes required on some projects.

Type of manhole construction varies by locality with brick, concrete blocks, pre-cast concrete manhole sections, and pre-cast fiberglass units being used. In more populated areas, pre-cast concrete manhole sections are now preferred

because of their superior strength, water tightness, and economical installation features.

3.11.1 Connections to Manholes and other Rigid Structures

There are several approved methods for connecting PVC sewer pipe to manholes and other structures, such as foundation walls. Unlike most other sewer pipe materials, concrete does not bond directly to PVC pipe. This means that some form of seal or water stop is required if there is to be a watertight connection between PVC pipe and concrete structures. The gasket installed on the spigot end of Perma-Loc will serve this function when grouted into the manhole. Other types of water seals are available and permissible. Using short lengths of pipe may help compensate for manhole settlement.

3.11.2 Preparation of Manhole for Future Connections

Sewer projects quite often include manholes from which sewer lines will be connected and installed at some future date. This situation frequently occurs in suburban developments where housing units are constructed in stages over a period of time. Where such future sewer extensions are planned, provisions should be made in the manholes to facilitate these connections.

3.11.3 Connections to Drop Manholes

Drop manholes are used to provide for significant changes in grade or elevation resulting from topography of the area. These structures should be used as infrequently as possible since they are a source of high turbulence in sewage flow. The WPCF Manual of Practice, No. 9, Chapter 6, states that where hydrogen sulfide gas is present in sewage, agitation and turbulence developed by drop manholes can cause the release of this gas in to the sewer atmosphere, resulting in severe odor problems or, under certain conditions, lethal, odorless concentration of the gas injurious to human health and instrumental to corrosion of concrete manhole structures.

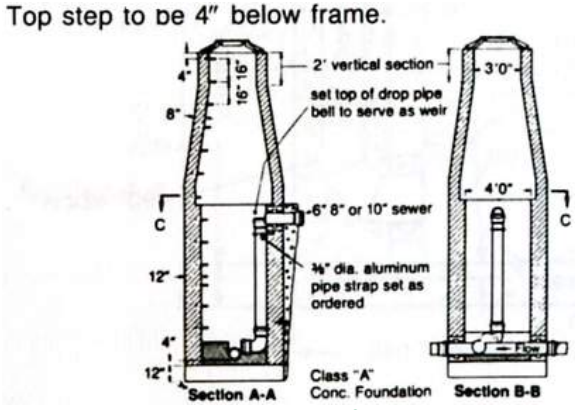
Two types of drop manholes are currently being designed for use with PVC plastic pipe.

1. Inside drop manholes.
2. Outside drop manholes.

The inside drop manhole has become the preferred method in many areas because of its economic and maintenance benefits.

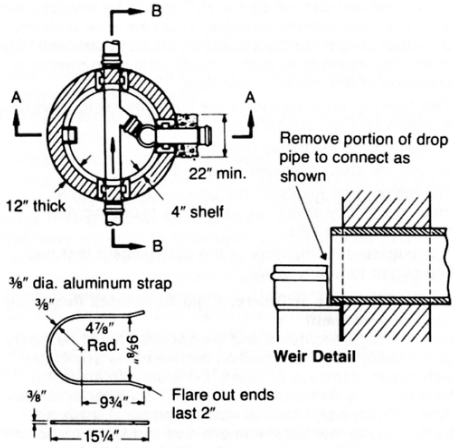
The outside drop manhole is the old standard that has been used for many years.

Inside Drop Manhole



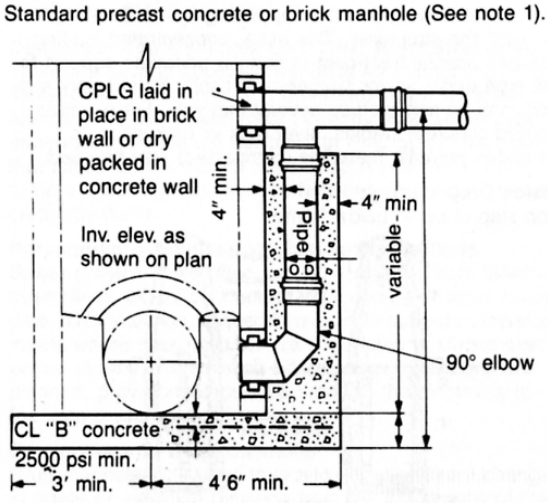
JMM Figure 12

Fill the excavated space outside of the manhole and under the pipe with "A" concrete or masonry for a width of 6" on each side of the pipe but not less than a total minimum of 22 inches.

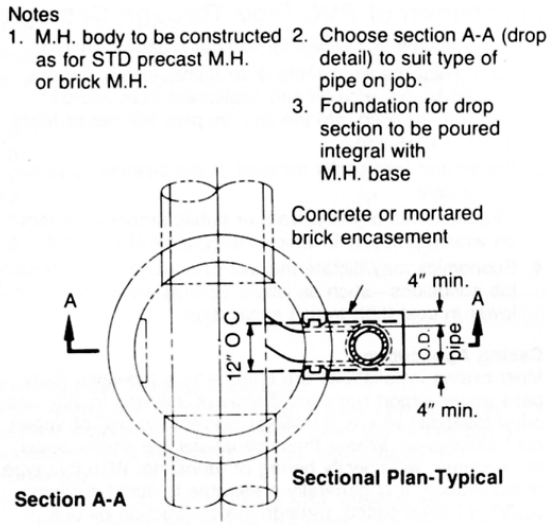


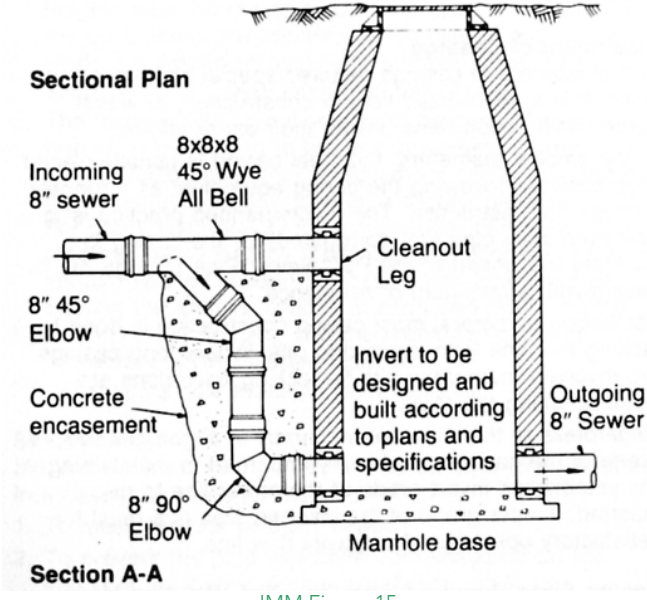
JMM Figure 13

Outside Drop Manhole



JMM Figure 14





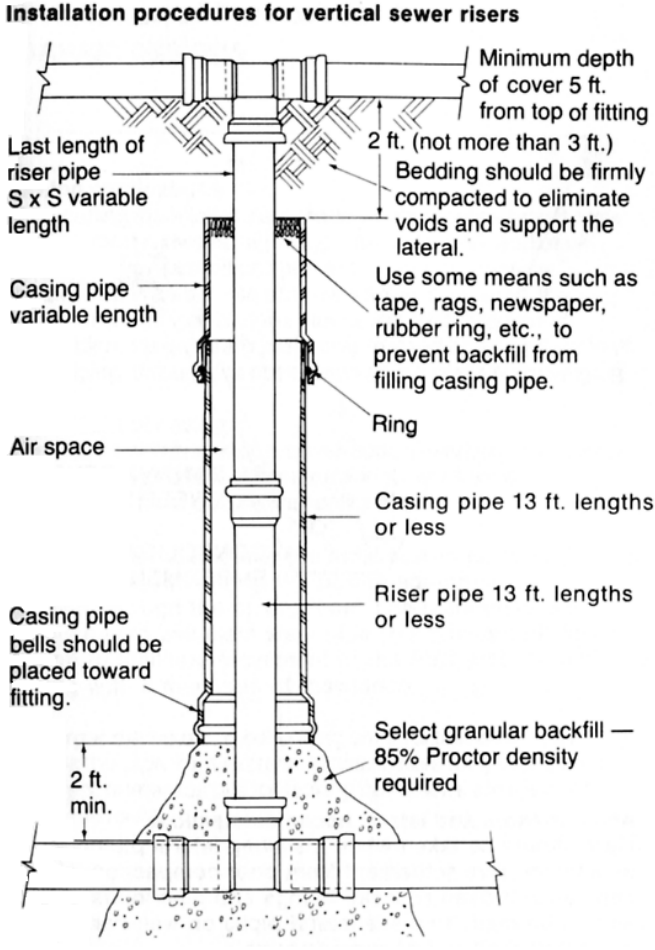
JMM Figure 15

3.11.4 Sewer Chimneys or Risers, Rigid Structures Requiring Special Treatment

Sewer design engineers and contractors should be aware of the design and construction requirements associated with sewer chimneys or risers. Frictional forces of the backfill above transfer considerable loads and surface loads to and through the chimneys or risers to the sewer pipe below. All of these loads are in turn transmitted in the form of concentrated weight to the supporting trench bedding beneath the structures. This extra, concentrated loading requires special treatment to provide adequate support for the pipe and fittings in sewer chimneys or risers. Satisfactory support may be achieved by several methods. For example, poured concrete cradles, layer rock or rock slabs, or hauled-in granular materials (compacted) may be used.

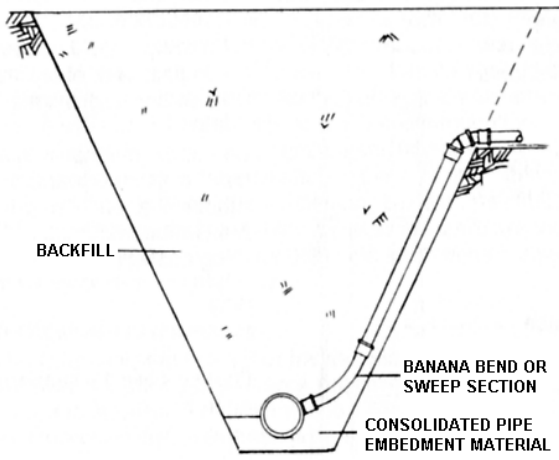
For vertical sewer chimneys, the following example illustrates recommended installation procedures for vertical risers (chimneys) using PVC sewer pipe and fittings. This installation recommendation should be employed for chimneys that exceed 12 feet of cover. If these recommendations in Figure 16 are not followed, there is a possibility that the vertical risers will be over-inserted into the fitting following soil consolidation. This may cause failure of the riser or fitting, failure of air or deflection tests, or blockage of the main sewer line.

NOTICE: Caution must be exercised when operating mobile equipment over pipelines with vertical risers during and following the backfill operations. Concentrated wheel loads can create excessive loading on fittings and mainline piping when transferred through vertical risers. The recommended minimum depth of cover for the upper chimney fitting is 5 feet.



JMM Figure 16

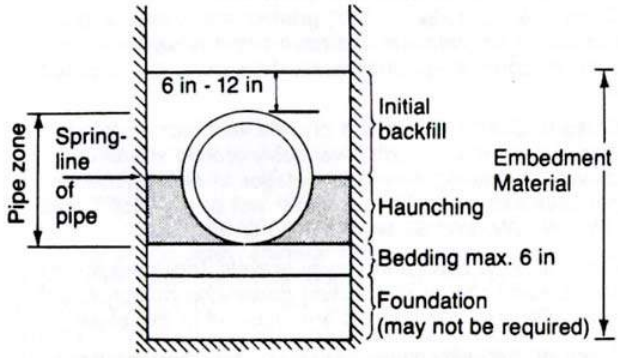
For angular risers and lateral house connections, care should be taken when installing lateral piping to avoid excessive settlement from poor compaction that can cause broken or leaky fittings and pipe joints. Efforts should be made to place lateral pipes on well-compacted or undisturbed soil wherever possible.



JMM Figure 17

4.0 Pipe Embedment

Below is an illustration of a typical trench with all major regions identified as they will be addressed in the following sections.



JMM Figure 18

4.1 Bedding

Bedding is required primarily to bring the trench bottom up to grade. Bedding materials should be placed to provide uniform longitudinal support under the pipe to prevent low spots. Blocking should not be used to bring the pipe to grade. Bell holes at every joint will allow for the joint to be assembled properly and maintain adequate support. Under normal circumstances a bedding of four (4) to six (6) inches compacted is of sufficient thickness for the bedding. If the native trench soil is comprised of fine grain soils and migration of those soils into the bedding material is anticipated, either wide trench construction, a well graded bedding material without voids, or a fabric barrier should be used to avoid compromising the trench backfill materials.

4.2 Backfilling and Tamping

Backfilling should follow pipe assembly as closely as possible. This protects the pipe from falling rocks, eliminates possibility of lifting the pipe from grade due to flooding of an open trench, avoids shifting pipe out of line by cave-ins, and in cold weather lessens the possibility of backfill material becoming frozen.

4.2.1 Haunching and Initial Backfill

There are two basic purposes of the haunching and initial backfilling of a flexible conduit such as PVC pipe:

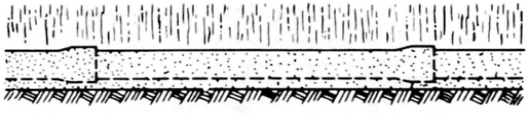
1. To provide the soil side support, which is necessary to enable the pipe and the soil to work together to meet the designed load requirements within the allowable deflection limits.
2. To provide protection for the pipe from impact damage due to large rocks, etc. contained in the final backfill.

The essentials of satisfactory haunching and initial backfilling can be summarized as follows: Provide approved materials, properly compacted continuously above the bedding and

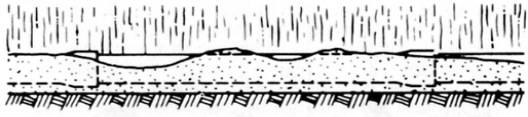
around the pipe to the spring-line, as well as between the pipe and undisturbed trench walls.

After the bedding material has been placed according to Section 4.1, place the haunching and initial backfill by hand to a one-foot minimum depth of cover above the pipe to give pipe support and cushion. In doing so proper control should be exercised to avoid vertical and horizontal displacement of the pipe from proper alignment. This backfill should be a selected material, free from rocks greater than 1.5 inches in diameter, dirt clods, or frozen material. This material is solely responsible for providing effective support of the pipe in the haunching area and limiting deflection. This is accomplished by tamping the embedment materials under the haunches and around the pipe to the spring-line of the pipe.

Side support is accomplished by tamping the soil firmly under the haunches of the pipe out to the trench walls. Tamping should be done in layers no greater than six inches. If automatic tampers are used, care should be exercised to avoid damaging the pipe. For more information on tamping, see Section 4.4.1.



A. Right—Backfill correctly placed by hand filling all voids



B. Wrong—Backfill not placed evenly.

JMM Figure 19

The immediate placement of initial backfill will provide adequate weight of soil on the pipe so that expansion and

contraction will be evenly distributed over each pipe length. This portion of the backfill begins at the spring-line of the pipe and extends to some predetermined distance above the pipe. Since little to no side support is derived from the soils placed in this area, native soils maybe used without tremendous compaction efforts, unless in the influence zone of other structures. It should be noted that at shallow depths of cover (less than three (3) feet) flexible conduits may deflect and rebound under dynamic loading if the trench width is not highly compacted, resulting in damage to road surfaces. For pipes buried under flexible road surfaces at depths less than three (3) feet, it is recommended that a minimum of 90% Proctor density be achieved from the bottom of the trench up to the road surface using Class I or Class II materials as described in Appendix 1. Minimum cover is recommended to be one foot from the top of rigid road surfaces or the bottom of flexible road surfaces.

4.3 Completing the Backfill

Balance of backfill need not be as carefully selected as the initial material, unless specified by the engineer. Care should be taken, however, to avoid including large stones that could damage the pipe by dropping on it or by being forced down on to the pipe under the weight of the final backfill.

4.3.1 Final Backfill

The final backfill should be placed and spread in uniform layers in such a manner as to completely fill the trench with a uniformly dense backfill load on the pipe and avoid unfilled spaces in the backfill. Rolling equipment should not be used until a minimum of 18 inches of backfill material has been placed over the top of the pipe. If a hydro hammer is to be used to compact the backfill, a minimum of three (3) feet of cover is required. Unless otherwise specified, trenches under pavements, sidewalks, or roads shall be backfilled and compacted to 90% density, as determined by the American Association of Highway and Transportation Officials Method T99 for State Compaction and Density of Soils. Unless

specified, other trenches may be backfilled without controlled compaction in the final backfill. Additional backfill material should be supplied, if needed, to completely backfill the trenches or to fill depressions caused by subsequent settlement. For description of backfill materials and their recommended usage, please refer to Appendix 1.

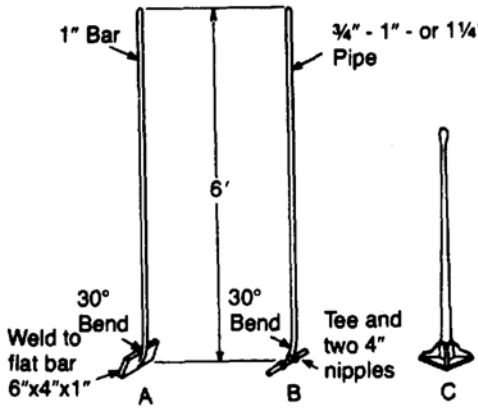
4.4 Compaction Methods

The first step in providing effective support for the pipe in the haunching area is to tamp the embedment materials under the haunches and around the pipe to the spring-line of the pipe.

Tamping should be done with hand tamping bars, mechanical tampers, or by using water to consolidate the embedment materials. With hand tamping, satisfactory results can be accomplished in damp, loamy soils and sands. For more cohesive soils, the necessary compaction may require the use of mechanical tampers. Water tamping should be limited to trenches excavated in soils in which water drains through quickly and, in so doing, compacts the embedment material.

4.4.1 Tamping Bars

Two types of tamping bars should be available for a good tamping job. The first should be a bar with a narrow head. (See A or B of Figure 20.) These are used to tamp under the pipe. The second tamping bar should have a flat head. It is used to compact the soil along the sides of the pipe to the trench walls. (See Figure 20 C.)



JMM Figure 20

Do not attempt to use the flat tamper (C) in place of A or B.

4.4.2 Mechanical Tampers

Care should be taken to avoid contact between the pipe and compaction equipment. Compaction of the embedment material should generally be done in such a way that the compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that the use of compaction equipment will not damage the pipe or cause deflection of the pipe.

When hydro-hammers are used to achieve compaction, they should not be used within three feet of the top of the pipe and then, only if the embedment material density has been previously compacted to a minimum 85% Proctor density.

4.4.3 Flood or Water Tamping

Flooding or water tamping should be used only in trenches that are excavated in soils from which water drains quickly and, at the same time, compacts the haunching material.
If flooding is used, the approved embedment material is first hand placed, making certain all voids under, around, and along both sides of the pipe and couplings are filled. Initial embedment material should be placed to a height sufficient to prevent floating of the pipe.

4.4.4 Water-Jetting

The introduction of water under pressure to the embedment material is not to be used to compact the embedment material of PVC pipe, or any other flexible conduit.

4.4.5 Sheeting and Trench Boxes

When sheeting is used, it should be left in place unless it is designed to prevent disturbing the soil adjacent to the pipe when pulled and removed. If heavy wooden sheeting has to be pulled, well-graded granular material should be placed on each side of the pipe for a distance of at least two pipe diameters. The granular material should be compacted to at least 90% Standard Proctor Density.

Whenever possible, sheeting and bracing should be installed so that the bottom of the sheeting extends no lower than the spring-line of the pipe. When installed in this manner, pulling the sheeting will not disturb the embedment material providing sidewall support for the pipe. If a trench box is used, it should be designed so that the backend of the sides do not extend below the pipe spring-line. This will allow filling and compaction of the annular space as the trench box is moved forward.

5.0 Pipe Testing and Repair

5.1 Pipe Deflection

Towns and municipalities normally set the long-term deflection limits of PVC at 7.5%. However, it should be noted that PVC sewer pipe will have a minimum safety factor of 4 in structural failure at this limit. To ascertain how a certain PVC product will deflect under various loading conditions, backfill types, and depths one may consult the UNI-BELL PVC Pipe Association (972-243-3902) or contact JMM Manufacturing for design charts specific to a situation.

5.1.1 Deflection Testing

It is the position of JMM Manufacturing that deflection testing of PVC pipe is unnecessary when pipe is installed in accordance with the acceptable practices stated in this

guide. Most towns and municipalities limit initial deflection to 5%, when in actuality PVC pipe will deflect 60% without splitting, cracking, or failing. Thus, exceeding these limits does not necessarily indicate any structural damage, failure, or reduction in life and only add to the cost of the project. Proof of this position is that more than 750,000,000 feet of PVC sewer pipe are performing satisfactorily in the field today. On the other hand, where improper installation practices are known or suspected, questionable bedding materials are employed, and/or installation conditions re severe, deflection testing of these sections of the installation should be considered advisable by the engineer. In the event that deflection measurement is a requirement, the following should be adhered to.

Two ways to measure deflection are 1) electronic deflect-o-meter and 2) Rigid "Go-No Go" Device. The most common and least expensive method in use is the rigid "Go-No Go" device. This device is pulled through the line and measures only on a "Go-No Go" basis.

When using a "Go-No Go" device to check deflection, the following steps should be taken.

1. Make sure the line is clean and free of debris that might cause the device to jam. It is recommended that the line be cleaned with a hydro-cleaner washing in the direction of flow.
2. The next step is to pull a line through the pipe with which to pull the "Go-No Go" device. This can be accomplished in several ways.
    a. If a hydro-cleaner is being used, attach the pull line to the nozzle end before the actual cleaning cycle starts. As the hose is pulled through the line, it will carry the pull line with it. When the hose nozzle reaches the manhole, disconnect the pull line and tie it off.
    b. A parachute device can be blown through the line with a lightweight string attached.

Detach the string, and attach the pull line. Manually drag the pull line through the pipe. Tie off at each manhole.

c. If a sewer line is in service, a string can be floated through the manhole run. When the string reaches the next manhole, attach it to the pull line and drag through. Tie the pull line at each manhole.

3. Pulling of the gauge is usually done by hand. The pulling motion should be smooth and easy to avoid jamming the gauge if an obstruction is encountered in the line. The gauge should have a line on each end to facilitate removal should the gauge become obstructed in the direction of pull. If the gauge stops lightly, pull on it to see if it will clear the obstruction. When it appears that the gauge will not go forward, record the distance from the manhole at which the gauge is stuck and then pull the gauge back out.

Do not use mechanical equipment to force the gauge though. This may result in a broken pull line.

When using a "Go-No Go" device, it is recommended that the design be such that it will allow obstructions, such as gravel, to pass through. For appropriate mandrel sizing, please contact JMM Product Assurance or consult the appropriate ASTM standard.

5.2 Making Leakage Tests

After the PVC sewer pipe has been laid and backfilled, each section of the pipeline between manholes should be tested by a low-pressure air test or a water infiltration test. There are some obvious advantages to the air test method such as:

1. A positive sound test method which provides accurate results
2. Time saving, especially in large diameters.
3. A clean test.

4. An inexpensive test compared with water exfiltration testing (water can be costly, particularly on large diameter jobs.)

When performing an air test, ASTM F 1417-92 (1998) "Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air" must be adopted for safety and consistency. However, the engineer reserves the right to choose the type of test (air or water) to be conducted. A comparison of the two test methods is very complex. Results can vary greatly depending both on the type of leak involved and the type of backfill material surrounding the pipe. For example, light clay soil versus clean sand. Because of the complexity of equaling the test results, these tests cannot be claimed to be strict equivalents. We do believe however, that both test specifications are meaningful and sound and will provide assurance of a defect-free, quality system.

5.2.1 Air Testing

When the air test is specified, the engineer should give explicit instructions for conducting the test in accordance with ASTM F 1417 practices, including times for a 0.5 psig pressure drop. Should any test on any section of the pipeline disclose an air loss rate greater than permitted, the contractor shall, at his own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the air loss rate is within the specified allowance.

Warning: When air is compressed in PVC pipe, it poses a severe explosion hazard and may result in pipe failure and/or injury to property and/or persons. Don't use PVC for compressed air systems. Do not exceed 9 psig of air pressure.

5.2.2 Infiltration Testing (water)

When high ground water tables exist and the infiltration test is required, the engineer shall give explicit instructions for conducting the test. The maximum allowable amount of

infiltration rate measured by the test shall be 50 gallons per inch of pipe diameter per mile per 24 hours. Should any test on any section of the pipeline disclose an infiltration rate greater than permitted, the contractor shall, at this own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the infiltration is within the specified allowance.

5.2.3 Exfiltration Testing (water)

When an exfiltration test is required, the engineer shall give explicit instructions to be followed in carrying out the test. The maximum allowable exfiltration rate measured by the test shall be 50 gallons per inch of diameter per mile per 24 hours. The average internal pressure of the system under test shall not be greater than 5 psi (11.6 ft. Head), and the maximum internal pressure in any part of the system under test shall not be greater than 10.8 psi (25 ft. Head). Should any test of any section on any section of the pipeline disclose and exfiltration rate greater than permitted, the contractor shall, at his own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the exfiltration is within the specified allowance.

5.3 Making Repairs to Damaged Pipelines

When pipe has been damaged and repair is required, all damaged material may be replaced in kind or the pipe may be repaired using a repair kit or other methods authorized by the engineer.

Minor to moderate cracks in Perma-Loc pipe may be repaired using strips of a Ram-Nek type material, and/or a concrete collar. A PVC, marine, or auto body epoxy type glue with fiberglass strands can also be used. For larger repairs it becomes necessary to use coupling fittings that will allow for splicing a new piece of pipe into place. Several fitting manufacturers have these fittings commonly available.

Other types of repair materials may be available. Please consult JMM for acceptability of these other products.

NOTICE: Trenches and/or casing should be constructed and used in accordance with all applicable state and federal standards to ensure safety.

NOTICE TO ALL READERS OF THIS GUIDE: PVC pipe installation may be hazardous to pipe, property, and/or persons if this guide and/or the recommendations of JMM Manufacturing are not adhered to fully. JMM has made every effort to expose all known dangers of misusing PVC pipe in this guide; however, JMM cannot possibly know or anticipate all situations or outcomes. JMM maintains the position that PVC pipe is the most reliable and safest piping material available. Thus, JMM encourages all users of our products to exercise good judgment when installing our products and to consult JMM for additional information when questions or concepts illustrated herein are not fully answered or understood. It is recommended that all users of our products (or persons handling) attend training on pipe construction, installation, and safety prior to working with our products to ensure safety, knowledge, and understanding. Should you need further assistance, please contact JMM Product Assurance at 1-800-621-4404.

Appendix 1
Embedment Materials

Materials suitable for foundation and embedment are classified in the following Table A1.1. They include a number of processed materials plus soil types defined according to the Unified Soil Classification System (USCS) in ASTM D 2487, "Standard Method for Classification of Soils for Engineering Purposes." Table A1.2 provides recommendations on the installation and use based on class of soil or aggregates and location within the trench. It is important to engineer all materials used in the pipe trench to work together and with the native material surrounding the trench.

Class IA Materials: Class IA materials provide the maximum stability and pipe support for a given density because of the angular interlocking of the material particles. With minimum efforts, these materials can be installed at relatively high densities over a wide range of moisture contents. These materials also have excellent drainage characteristics that may aid in the control of water. These soils are often desirable as embedment in rock cuts where water is frequently encountered. On the other hand, when ground water flow is anticipated, consideration should be given to potential migration of fines from adjacent materials into the open graded Class IA materials.

Class IB Materials: Class IB materials are produced by mixing Class IA and natural or processed sands to produce a particle-size distribution that minimizes migration from surrounding soils that may contain fines. They are more widely graded than Class IA and thus require more compaction effort to achieve the minimum density specified. When these materials are properly compacted these soils exhibit high stiffness and strength, and depending on the amount of fines, may be relatively free draining.

Class II Materials: When Class II materials are compacted, they provide a relatively high level of pipe support. In most

respects, they all have the desirable characteristics of Class IB materials when widely graded. However, open-graded groups may allow for migration and the sizes should be checked for compatibility with the native trench materials. Typically, Class II materials consist of rounded particles and are less stable than the angular materials of Class IA and IB unless they are confined and compacted.

Class III Materials: These materials provide less support for a given density than Class I or Class II materials. High levels of compaction effort are required if moisture content is not controlled. These materials will provide reasonable support once proper compaction is achieved.

Class IV-A Materials: Class IV-A materials must be carefully evaluated before use. The moisture content of the materials must be near optimum to minimize compaction effort and achieve the required density. Properly placed and compacted, these soils can provide reasonable levels of pipe support. However, these materials may not be suitable under high fills, surface applied dynamic loads, or under heavy vibratory compactors and tampers. These materials should be avoided if water conditions in the trench may cause instability and result in uncontrolled water content.

JMM Table A1.1

Table A1.1										
Description of Material Classification as Defined in ASTM D 2321										
				Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
Class	Type	Soil Symbol Group	Description ASTM D 2487	1.5 in (40mm)	No.4 (4.75mm)	No.200 (.075mm)	LL	PL	Uniformity Cu	Curvature Cc
IA	Manufactured Aggregates: open graded, clean	None	Angular, crushed stone or rock, crushed slag, cinders or shell: large void content, contain little or no fines	100%	< or =10%	<5%	Non Plastic			
IB	Manufactured, Processed Aggregates: dense graded, clean	None	Angular, crushed stone (or other Class IA materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils: contain little to no fines	100%	< or =50%	<5%	Non Plastic			

*JMM Table A1.1 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

Table A1.1 Continued										
				Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
Class	Type	Soil Symbol Group	Description ASTM D 2487	1.5 in (40mm)	No.4 (4.75mm)	No.200 (.075mm)	LL	PL	Uniformity Cu	Curvature Cc
II	Coarse-Grained Soils: clean	GW	Well-graded gravels and gravel-sand mixtures: little to no fines	100%	<50% of coarse fraction	<5%	Non Plastic		>4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures: little to no fines						<4	<1 or >3
		SW	Well-graded sands and gravelly sands: little to no fines		>50% of coarse fraction				>6	1 to 3
		SP	Poorly-graded sands and gravelly sands: little to no fines						<6	<1 or >3
	Coarse-Grained Soils: borderline clean to w/fines		Sands and gravels which are bordeline between clean and with fines	100%	varies	5% to 12%	Non Plastic			Same as for GW, GP, SW, and SP

*JMM Table A1.1 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

Table A1.1 Continued										
				Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
Class	Type	Soil Symbol Group	Description ASTM D 2487	1.5 in (40mm)	No.4 (4.75mm)	No.200 (.075mm)	LL	PL	Uniformity Cu	Curvature Cc
III	Coarse-Grained Soils w/ Fines	GM	Silty gravels, gravel-sand-silt mixtures	100%	>50% of coarse fraction	>12% to <50%		<4 or <"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures					<7 and >"A" Line		
		SM	Silty sands, sand-silt mixtures		>50% of coarse fraction			>4 or <"A" Line		
		SC	Clayey sands, sand-silt mixtures					>7 and >"A" Line		
IV-A	Fine-Grained Soils: Inorganic	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity	100%	100%	>50%	<50	<4 or <"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays					>7 and >"A" Line		

*JMM Table A1.1 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

JMM Table A1.2

Table A 1.2

Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill

Soil Class as Defined in Table A1.1

	Class IA	Class IB	Class II	Class III	Class IV-A
General Rec-ommendations and Restrictions	Do not use where condtions may cause migration of fines from adjacent soil and loss of pipe support. Suitable for use as a drainage blanket and underdrain in rock cuts where adjacent material is suitably graded.	Process materials as required to obtain gradation which will minimize migration of adjacent materials. Suitable for use as drainage blanket and underdrain.	Where hydraulic gradient exists check gradation to minimize migration. "Clean" groups suitable for use as drainage blanket and underdrain.	Do not use where water conditions in trench may cause instability.	Obtain geotechnical evaluation of processed material. May not be suitable under high earth fills, surface applied loads and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated trench bottom as restricted above. Do not use in thicknesses greater than 12 inches total. Install and compact in 6 inch maximum layers.	Suitable only in undisturbed condition and where trench is dry. Remove all loose material and provide firm, uniform trench bottom before bedding is placed.

*JMM Table A1.2 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

Table A1.2 Continued					
Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill					
Soil Class as Defined in Table A1.1					
	Class IA	Class IB	Class II	Class III	Class IV-A
Bedding	Suitable as restricted above. Install in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable as restricted above. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable only in dry trench conditions. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).
Haunching	Suitable as restricted above. Install in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.

*JMM Table A1.2 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

Table A1.2 Continued					
Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill					
Soil Class as Defined in Table A1.1					
	Class IA	Class IB	Class II	Class III	Class IV-A
Initial Backfill	Suitable as restricted above. Install to a minimum of 6 inches above pipe crown.	Install and compact to a minimum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.
Final Backfill	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Suitable as restricted above. Compact as required by the engineer.

*JMM Table A1.2 provided courtesy of the Uni-Bell PVC Pipe Association, "Handbook of PVC Pipe Design and Construction", 4th edition, August 2001.

SEWER/STORM DRAIN

PERMA-LOC

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