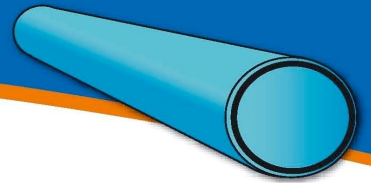




PIP Pipe
Installation Guide



**Recommendations
for
Installation
of
IPS & PIP
Pressure Pipe**

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DIAMOND PVC PIPE

Diamond Plastics Corporation supplies PVC pipe of Iron Pipe Size (IPS) and Plastic Irrigation Pipe (PIP) dimensions with integral coupling that utilizes an elastomeric gasket for an assembled seal. In this guide we will outline the basic handling, storage, assembly, and installation procedures for these products.

-Installation Guide Disclaimer-

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-Receiving and Handling-

Inspection: Each pipe shipment should be inspected carefully upon arrival. The carrier is responsible for delivering the pipe. The receiver must make certain there has been no loss or damage. Should there be any errors or damage, make proper note on the delivery receipt. Make claim in accordance with the carrier's instruction. Do not dispose of any damaged material. Carrier will advise you of the procedure to follow for freight damage.

Pipe at the bottom of the 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. Under freezing conditions this recovery to full initial roundness may take several hours or a few days. (Unusually hot weather conditions may also contribute to a degree of out-of-roundness. Self correction usually occurs as the temperature normalizes.)

Unloading - Cold Weather Handling: Extra care should be used in handling during cold weather.

WARNING: Carelessly unloading pipe can be hazardous. Use appropriate equipment and stay clear when removing tie-downs, banding, and dunnage material. Do not attempt to handle pipe bundles by pulling on strapping or packaging material.

-Trench Preparation-

Proper installation procedures and trench preparation are essential to successful PVC pipe performance. Trench preparation procedures for PVC pipe do not vary substantially from procedures used with other piping products. There should be no more trench prepared than the footage of pipe which can be laid in a day. A typical trench cross section and terminology are given in figure 1. (The illustration of Trench Cross-Section and Terminology assumes installation of one pipeline per trench.)

Stringing Pipe: Pipe should be placed near the trench on the opposite side of the excavated earth. The coupling should be pointed in the direction of work progress.

Trench width: Trench load and working space are two important considerations in determining the trench width to be used. The wider the trench at the top of the pipe, the greater the earth load imposed on the pipe. Trench width should allow sufficient room to work safely, for proper alignment and assembly of the joints. The outside diameter of the pipe plus one foot should be considered the minimum trench width at the height of the top of the pipe. The maximum trench width at the top of the pipe is equal to the pipe outside diameter plus two feet. Enlargement of the trench width, if necessary, should be to the trench area above the top of the pipe.

When more than one pipeline is installed in a common trench, pipe to pipe contact is not permitted. The pipes must be separated by a minimum of six inches of haunch material, and the pipe-zone haunching must be compacted on both sides of each pipe.

Depth: The trench depth should be established, after consideration is given to the requirements for the foundation, bedding, grades, pipe size, and cover by the design engineer of the piping system. A minimum of three feet of cover is recommended when surface loads are expected. The pipe should be buried below the plow depth and below the depth of frost penetration.

Foundation: An adequate or stable foundation should be present (or provided) to uniformly support the full length of the pipe. Bell holes should be provided at each joint to permit proper assembly and support of the pipe. Unstable trench bottoms shall be stabilized by methods and with materials required, by the specifying engineer, to provide adequate and permanent support for the conditions encountered.

Bedding: When rock, hard pan, boulders, or other material (which might damage the pipe) are encountered in the trench, the trench bottom should be over excavated 1/4th of the pipe diameter, or a minimum of four inches to permit bedding. The bedding should consist of an evenly graded, free flowing, granular material that is free of stones or other hard particles larger than 3/4 inch in size. Bell holes should be utilized to reduce axial deflection and support the barrel of the pipe.

-Assembly-

Assembly is made by sliding the lubricated spigot end into the gasketed bell end. The gasket seals the joint against leaks, into or out of the pipeline.

Clean dirt and foreign material from the gasketed socket and the spigot end. Uniformly, apply Diamond furnished lubricant to the spigot end of the pipe up to the insert reference mark and to the gasket surface which makes contact with the spigot end of the pipe.

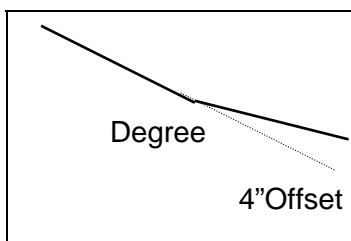
Insert the spigot end into the socket so that it is near contact with the gasket. Keep the pipe lengths in proper alignment. Proper alignment is described as no angle being formed between the spigot and bell. They should be in straight alignment. Brace the bell while the spigot end is pushed through the gasket so that previously completed joints in the line will not be “stacked,” “over belled,” or inserted past the insert reference mark. Push the spigot end in until the insert reference mark on the spigot end is flush with the end of the pipe. If the spigot is inserted beyond the insert reference mark, laying length will be lost. Loss of laying length can be significant on long footage projects. Also, joint flexibility is reduced when the spigot is inserted beyond the insert reference mark. Over-insertion of the spigot may lead to excessive stress and joint failure. Some joints may require barring to seat the joint. If so, use a wood block to protect the end of the pipe. A come-a-long may be preferred to the bar and block. A swinging stab is not recommended. Where the physical weight or trench conditions make the recommended methods unsafe, joints may be assembled using mechanical equipment provided that the pipe is properly lubed and aligned. The end must be protected from damage, and the joint must not be “over belled” or inserted beyond the insert reference mark.

-Lubricant-

An even, uniform application of gasket lubricant must be applied to the spigot including the bevel and to the insert reference mark as well as the contact surface of the gasket. Gasket lubricant may be applied with a swab, brush, or roller. An adequate amount of gasket lube is furnished with each truckload of pipe. Additional lubricant may be purchased from your distributor.

Curvilinear Alignment (Without Bending the Pipe.)

During construction, it may become necessary to make very slight changes of direction.



When this situation is encountered, the clearance between the inside diameter of the socket and the outside diameter of the spigot may be utilized to accomplish curvilinear alignment without bending the pipe. Neither the pipe nor the joint should be axially deflected in any manner to cause stress at the joint. Assuming the spigot is not “over-inserted” beyond the insert reference mark, Diamond PVC pipe will accommodate a 1° change in direction per joint. With 20’ joints this is a 4” offset. For 20’ joints the minimum curve radii is 1,146 feet. If the spigot is “over-inserted” beyond the insert

reference mark, allowable joint offset and laying length will be lost. On long projects, the cumulative loss of laying length can be significant.

TRENCH CROSS-SECTION SHOWING TERMINOLOGY

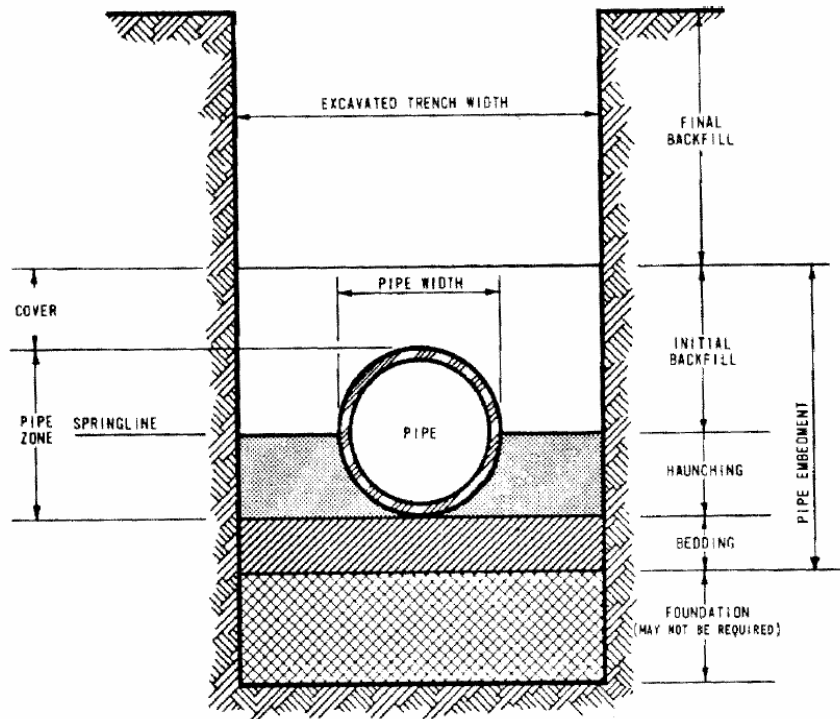
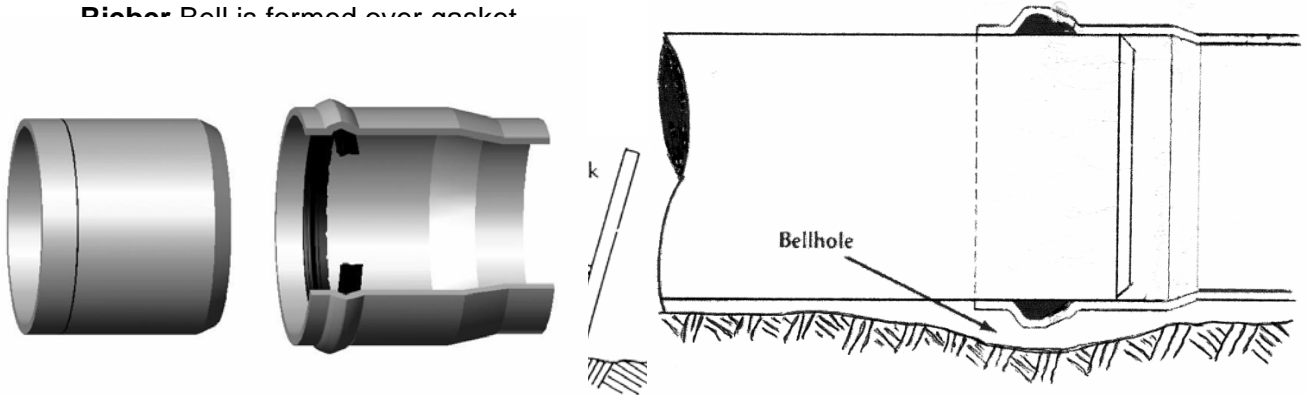


Figure No. 1

Digger Bell is formed over gasket



2. Use a bar and block for leverage

-Thrust Blocking-

Diamond's gasketed PVC pipe utilizes an integral bell socket with an elastomeric sealing gasket and is not self restraining. Therefore, thrust blocking is required at certain points in the piping system such as at valves, change in horizontal or vertical direction fittings, change in line size fittings, and at end fittings.

Design: Thrust blocks should be designed with consideration given to the maximum of service or test pressure to be sustained. The following table indicates the holding power of

various soils against horizontal thrust assuming a minimum of two feet of soil covers the pipe. A design engineer should be consulted regarding the specifics of each particular project.

Bearing Load

<u>Soil Type</u>	<u>Pounds / sq.ft.</u>
Soft Clay	500
Sand	1,000
Sand & Gravel	1,500
Sand & Gravel w/clay	2,000
Hard Pan	5,000

As noted above, great force is developed at the certain point previously noted. Normally, the highest forces are developed from a 90 degree elbow. The following table assumes a 90 degree elbow at 100 psi.

Thrust at 90 degree elbow*

<u>Pipe Size</u>	<u>Thrust</u>
4" PIP	2,240
6" PIP	4,830
8" PIP	8,200
10" PIP	12,750
12" PIP	18,200
15" PIP	26,000
18" PIP	38,000
21" PIP	54,000
24" PIP	67,000
27" PIP	75,000

* based on 100 psi operating pressure

The size of the thrust block should be adequate to prevent pipe movement at the point of thrust. Dimensional requirements of the thrust block are specified by the designing engineer of the piping system.

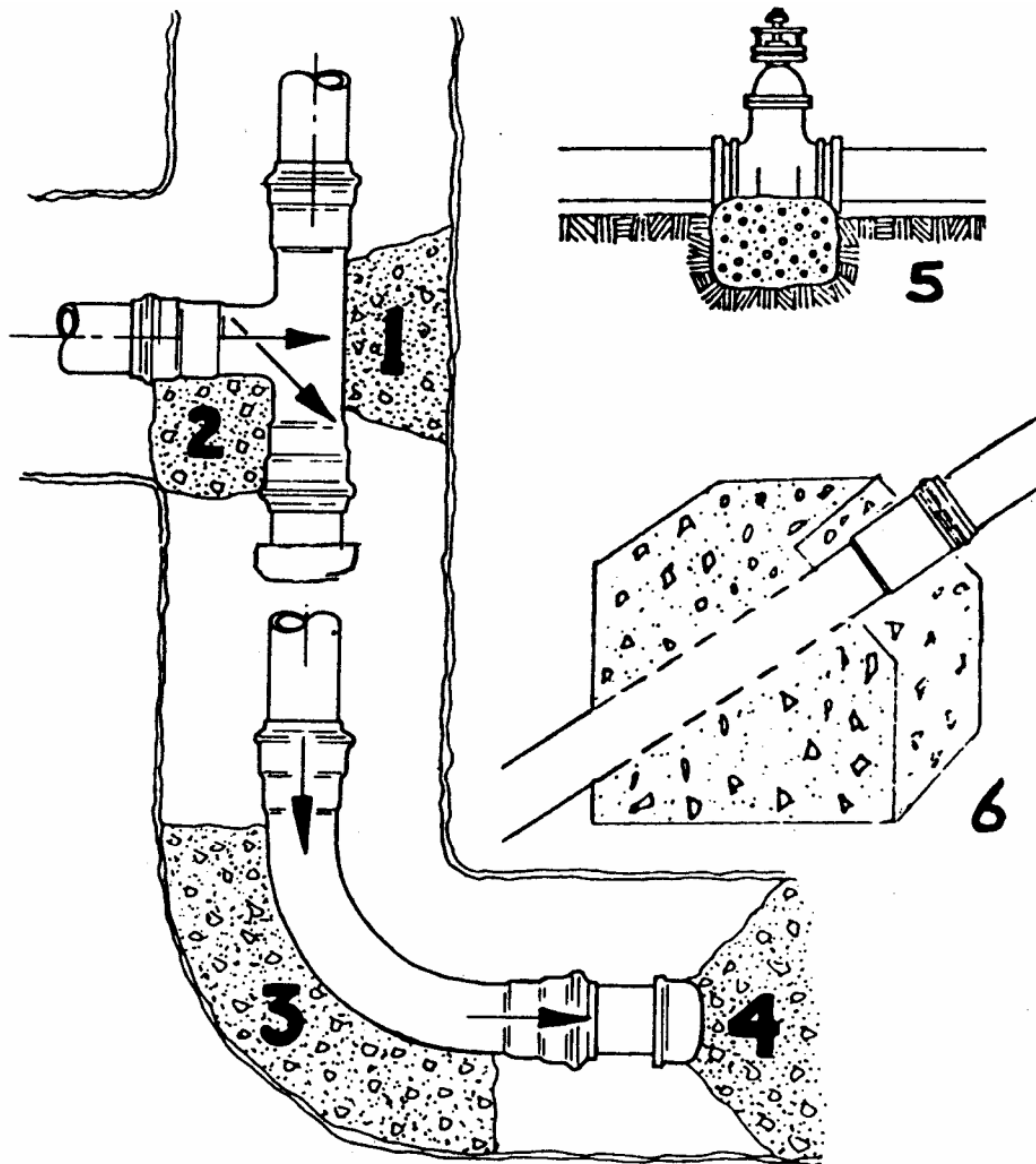


Figure No. 4

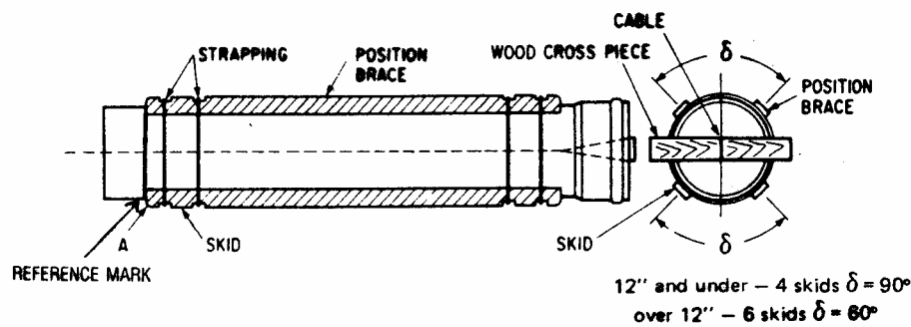
THRUST BLOCKS

- 1. Tees
- 1 & 2. Plugged End of Tee
- 3. 90° Elbow
- 4. End Caps or Plugs
- 5. Valve
- 6. Steep Incline

Construction: Thrust blocks should be constructed directly in line with the force created by the pipe or fitting. The cavity for the thrust block should be hand dug into undisturbed soil. Simple forms are adequate to hold the freshly poured concrete. Concrete should be fluid enough to be worked around the fitting and should have compression strength not less than 2000 psi. Prior to pressurizing the pipeline, make sure the concrete has adequate time to set.

-Casings-

Casings may be installed by boring where open excavation is not desirable, for example, under highways, runways, or railways. To provide long term support to the pipe and to prevent damage to belled sockets during installation, skids or casing spacers must be attached to the pipe before the pipe is installed in casings. Casing spacers are commercially available. Untreated wood may be used as a skid. Skids should be fastened securely to the pipe with steel strapping, cables, or clamps. Care should be exercised to place skids or casing spacers at insertion mark to avoid overbelling. Use of gasket lube between the skids and the casing can ease installation into the casing. (Caution: Exposure to petroleum products can damage some elastomeric gaskets.)



-Haunching & Initial Backfill-

Initial backfill is completed in two stages and should be completed as soon as possible after the pipe has been laid. The first stage (haunching) should be placed in layers of no more than six inches at a time up to the springline of the pipe. Compact as required by the designer of the pipe system. The second stage of initial backfill is again placed in no more than six inch layers from the springline to a point 6 to 12 inches above the top of the pipe. Both stages of initial backfill material shall be free of large stones (3/4" or larger) frozen material, or debris.

-Acceptance Testing-

If portions of the pipeline are tested as they are completed, the portion to be tested must be sufficiently backfilled and braced to prevent movement while under test pressure. If contract specifications require the joints to be exposed for observation during testing, center load the pipe lengths to prevent movement. Slowly fill the pipeline, limiting the flow to approximately one foot per second, making sure that there is no imposed surge or water hammer. Entrapped air can cause tremendous surge pressures resulting in dangerous and explosive conditions. All air must be expelled from the pipeline before making

pressure or leakage tests. The pipeline should be filled but not pressurized until ready to conduct the leakage / pressure tests. Appropriate pressure relief, air release and vacuum release valves should be installed prior to testing. The location of relief valves should be determined by the design engineer. Duration of test pressures should be in accordance with the contract specifications as set forth by the designing engineer, however, the test pressure should not exceed design pressure for pipe, appurtenances, or thrust restraints.

**APPROXIMATE VOLUME OF WATER
REQUIRED TO FILL**

U.S. Gallons/100 feet of pipe

<u>Pipe Size</u>	<u>IPS</u>	<u>PIP</u>
2"	19	-
2 ½"	30	-
3"	42	-
4"	70	-
6"	153	145
8"	259	250
10"	405	385
12"	573	555
15"	-	865
18"	-	1300
21"	-	1800
24"	-	2275
27"	-	2890

Air pressure testing of installed PVC pressure pipe is expressly prohibited for reasons of safety, should failure occur.

A leakage test is generally conducted to determine all joints, fittings, and other appurtenances do not leak. Normal operating pressure is usually applied for leakage tests. Measurement of the amount of additional water pumped in during the test provides a measurement of the amount of leakage, if any. An allowance, if provided, gives the installer some provision for engagement of joint restraints, seating of gaskets, slight swelling of the pipe diameter, temperature variations, and the like. A testing allowance is not provided to permit a pressure piping system to literally leak. A properly installed pipeline will require little or no make-up water.

In the event of a leak, generally, it can be traced to a damaged or dislodged gasket, incomplete solvent-cement joint, broken pipe or fitting, loose mechanical joint, or inadequate thrust block. Usually these problems are easily detected and quickly repaired. Any leaks must be repaired before pressure testing.

The allowable leakage (gallons per hour) should not be greater than that determined by the following formula:

$$L = \frac{ND\sqrt{P}}{7,400}$$

Where: **L** = testing allowance, gal/hr
N = number of joints in the tested line (pipe and fittings)
D = nominal diameter of pipe, in
P = average test pressure, lb/in²

The above equation calculates an allowable leakage of 10.5 gallons per inch of diameter, per mile, per day, at a pressure of 150 psi. The same precautions and procedures exercised during pressure tests should also be taken in preparing the pipeline for the leakage tests. Purge the pipeline of any entrapped air, and test in accordance with contract specifications.

-Solvent-Cement Joints-

Solvent-cement joints should be made using solvent-cements meeting the requirements of ASTM D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems in accordance with ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings. These procedures include cutting and deburring, cleaning the surfaces to be joined, and applying primer and cement to the joining surfaces as outlined below.

1. Cleaning and priming are very important procedures in solvent cementing. Surface breakdown of the parts to be cemented is essential for a good joint. Apply primer according to manufacturer's recommendations over all surfaces to be cemented. Surface breakdown has occurred when a few thousandths of surface can be scraped off with a pocket knife. Cementing materials are temperature related, so periodically, check amount of material and time required for surface breakdown.
2. Use proper type of cement for the size and type of pipe, stir cement and apply a full even coat on the male end to a depth equal to the socket depth.
3. Apply a medium layer to the socket of the fitting, and avoid puddling in the socket.
4. Then, apply a second even coat to male end of the pipe. All cement layers must be without voids.
5. Push pipe and fitting together immediately while cement is wet, enough force must be used to have the male end bottom out. Twist pipe ¼ turn while inserting it.
6. Hold, to resist the inherent repelling action of the chemical bond, the assembled pipe for approximately 10 seconds, depending on the weather (hot weather will cause pipe to bond sooner.)
7. A proper cementing job will have 1/8" cement bead around the joint.
8. Remove all excess cement around the joint. Paper toweling is recommended for removing the excess cement.
9. Handle newly cemented sections carefully.

-Final Backfill-

After placement and compaction of pipe embedment materials, the balance of backfill materials may be returned to the trench. The material should not contain large stones or rocks, frozen materials, or debris. Compaction procedures of the remainder of the backfill should be in accordance with the contract specification.

LOW HEAD PIPE

(50'hd, 100'hd, 50 psi, & 63 psi)

Installation of low head pipe is basically the same as other gasketed pipe except that particular care must be taken in properly bedding and backfilling the trench where the pipe is installed.

Water Packing:

- (1) Pipeline must first be filled with water, purged of all air and remain full of water during the backfill operation.
- (2) The initial backfill immediately surrounding the pipe shall be of fine-grained material free from rocks, stones, etc. larger than 3/4" in diameter and earth clods larger than 3" in diameter.
- (3) The initial backfill before wetting shall be 12 to 18 inches deep over the top of the pipe.
- (4) Water packing is accomplished by adding water in such quantity as to thoroughly saturate the initial backfill.
- (5) After saturation, the pipeline is to remain full of water until after the final backfill is complete.
- (6) The wetted initial backfill shall be allowed to dry until firm enough to walk on without sinking.
- (7) Final backfilling may occur after the initial backfill has dried and firmed sufficiently.

-Discharge and Stand Assemblies-

The first step in installing a low head pipeline is the assembly of the discharge or pump-stand. The following is a brief description of both systems:

- (1) *Stands* - The bottom of the trench should be exposed down to the undisturbed soils and shaped to fit the bottom of the stand. Stands require a firm base. First place stand on the undisturbed soil, place the first section of pipe in the trench and connect it to the stand. Level the stand and tamp in enough dirt to hold in place. Finish installing the necessary pressure relief, air vent and/or other apparatus.
- (2) *Pump Discharge* - Certain conditions dictate the use of flap valves in the discharge pipe between the pump and the pipeline. There should be a vacuum release valve between the pump and the flap valve.
- (3) Follow the instructions of the designer as to the proper size and location of Pressure Relief Valves (PRV), Air Release Valves (ARV), Vacuum Release Valves (VRV) and Air-Vacuum Release Valves (A-VRV) at pump, gate valves, high points, ends of line and other strategic locations in the pipeline.

TYPICAL DISCHARGE AND VENT ASSEMBLIES
Type "C" Open Stand
Low Head

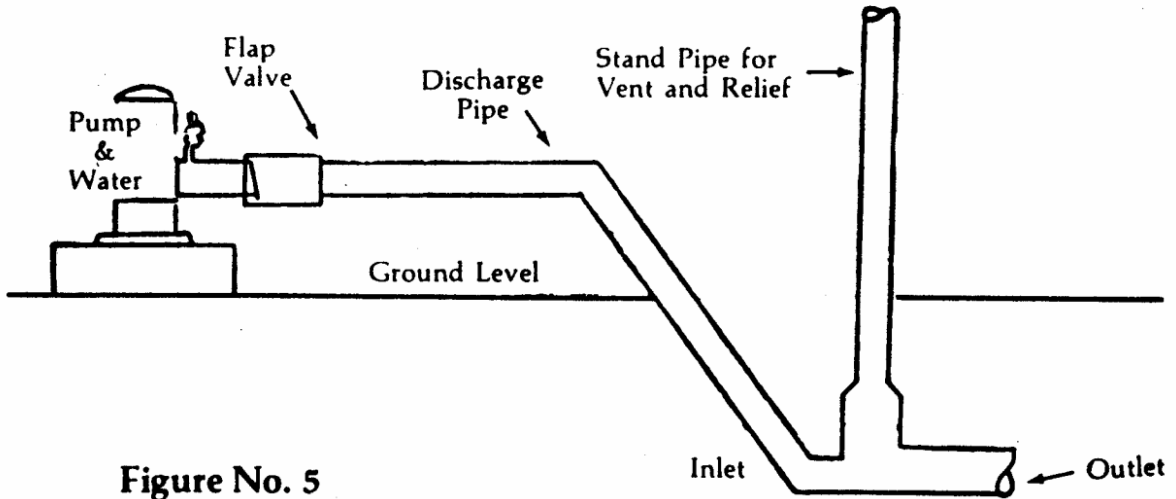


Figure No. 5

TYPICAL DISCHARGE AND VENT ASSEMBLIES
Type "C" Open Stand
Low Head

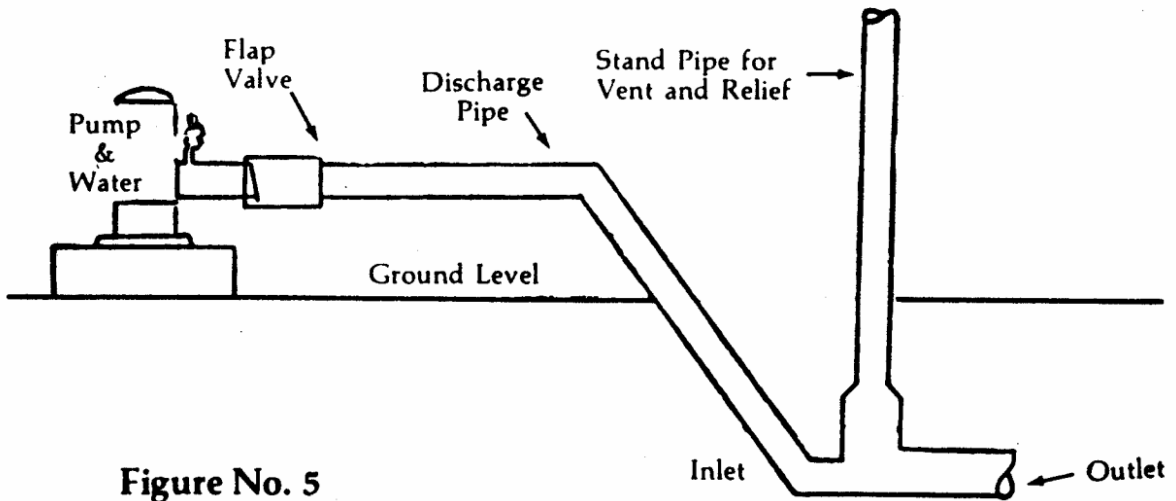


Figure No. 5

**Type "C" Closed Stand
Low Head**

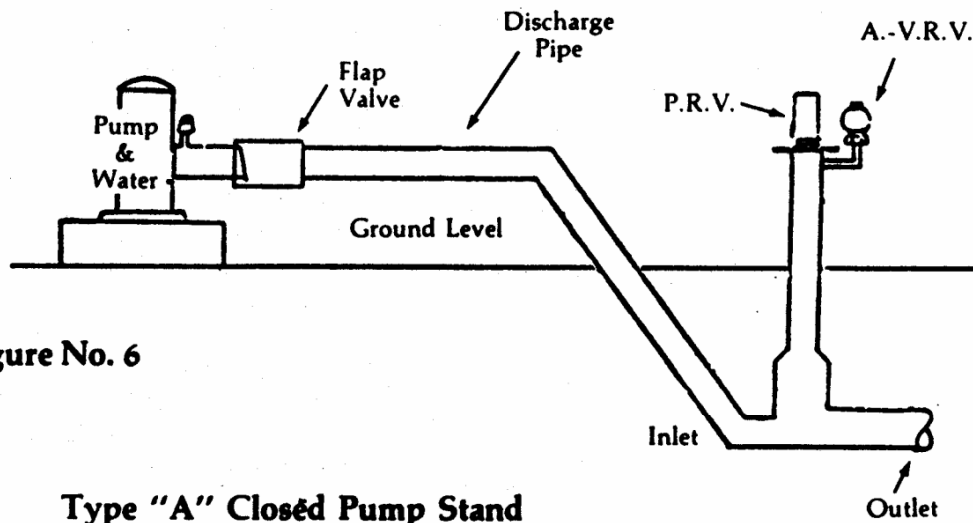


Figure No. 6

**Type "A" Closed Pump Stand
Low Head**

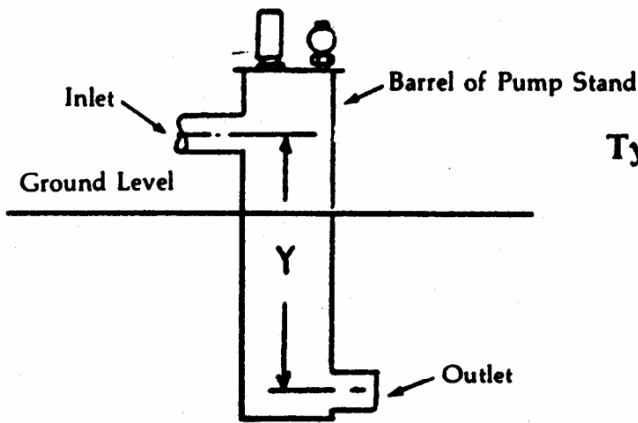


Figure No. 7

**Type "A" Pump Stand
Low Head**

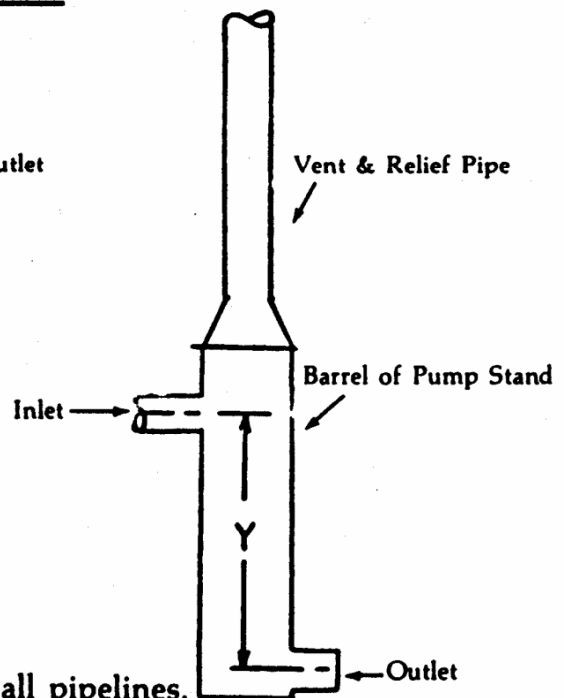
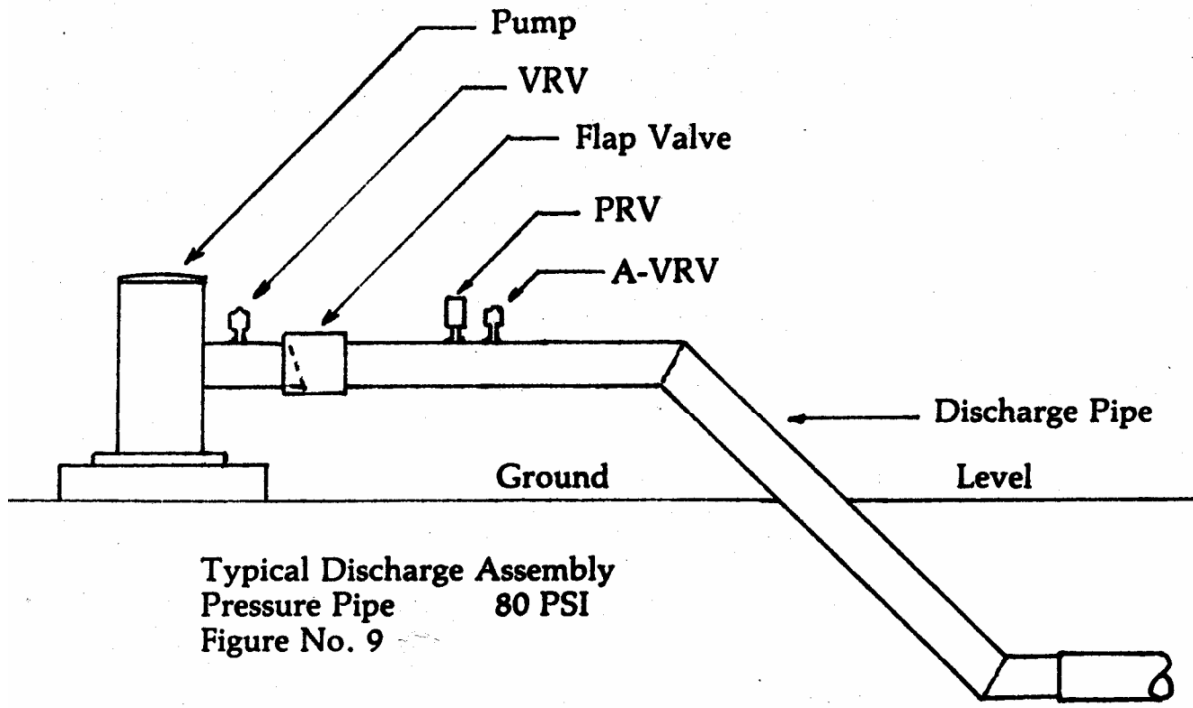


Figure No. 8

Check valves to be used at pumps on all pipelines.



Repairs may be made with bolted couplings or gasketed couplings and lengths of plain ended pipe.



FRICTION LOSS CHARTS FOR DIAMOND PIPE IPS DIMENSION

Q Gallons Per Min.	1-Inch	1¼-Inch	1½-Inch	2-Inch	2½-Inch	3-Inch	3½-Inch
FRICTION HEAD LOSS IN FEET PER HUNDRED FEET							
2	.15	.04	.02				
4	.54	.17	.09	.03	.01		
6	1.15	.37	.19	.06	.02		
8		.63	.32	.11	.04	.01	
10	2.98	.95	.49	.16	.06	.02	.01
15	<u>6.32</u>	2.03	1.04	.35	.14	.05	.02
20	<u>10.79</u>	3.46	1.78	.60	.23	.09	.04
25	16.30	<u>5.22</u>	2.70	.91	.36	.13	.07
30	22.86	<u>7.32</u>	3.78	1.27	.50	.19	.10
35		9.75	<u>5.03</u>	1.70	.67	.25	.13
40		12.46	<u>6.46</u>	2.18	.86	.32	.17
45		15.51	8.02	2.71	1.07	.40	.21
50		18.87	9.75	3.30	1.30	.49	.25
55		22.48	11.64	<u>3.94</u>	1.54	.59	.30
60			13.64	<u>4.62</u>	1.81	.69	.38
65			15.85	5.36	2.10	.80	.41
70			18.19	6.14	2.42	.92	.47
75			20.65	6.99	<u>2.75</u>	1.06	.55
80			23.28	7.86	<u>3.10</u>	1.19	.62
85				8.81	3.47	1.33	.69
90				9.79	3.85	1.48	.77
95				10.82	4.25	1.64	.85
100				11.89	4.69	1.80	.93
110	Table based on Hazen-Williams equation— $C_w = 150$			14.21	5.59	2.14	1.11
120				16.69	6.56	<u>2.52</u>	1.31
130				19.35	7.63	<u>2.92</u>	1.53
140	1/ To find friction head loss in PVC pipe having a standard dimension ratio other than 21, the values in the table should be multiplied by the appropriate conversion factor (F) shown below:			22.21	8.73	3.36	1.75
150					9.94	3.82	1.99
160					11.20	4.29	<u>2.24</u>
170					12.51	4.80	<u>2.50</u>
180					13.90	5.35	2.79
190					15.39	5.92	3.08
200					16.91	6.50	3.38
220					20.19	7.77	4.04
240					23.73	9.12	4.76
260						10.57	5.51
280						12.11	6.32
300						13.78	7.18
320						15.52	8.10
340						17.37	9.07
360						19.27	10.08

SDR	PR	F
21	200 PSI	1.00
26	160 PSI	.91
32.5	125 PSI	.84
41	100 PSI	.785
51	80 PSI	.75
64	63 PSI	.71

Loss below bold line indicates velocities in excess of 5 feet per second.
Velocities which exceed 5 feet per second are not recommended.



**FRICION LOSS CHARTS
FOR DIAMOND PIPE
PIP DIMENSION**

Q
Gallons
Per Min.

6-Inch 8-Inch 10-Inch 12-Inch 15-Inch

FRICION HEAD LOSS IN FEET PER HUNDRED FEET

300	.89				
320	1.00				
340	1.12				
360	1.25				
380	1.38				
400	<u>1.52</u>				
420	1.66	.42	.14	.06	
440	1.81	.45	.15	.06	
460	1.96	.49	.17	.07	
480	2.13	.53	.18	.07	
500	2.29	.57	.19	.08	
550		.69	.23	.10	
600		.81	.27	.11	
650		<u>.93</u>	.31	.13	
700		1.07	.36	.15	
750		1.22	.41	.17	
800		1.37	.46	.19	
850		1.53	.52	.21	
900		1.71	.58	.24	
950		1.89	.64	.26	
1000		2.07	.70	.29	.12
1050			.77	.31	.12
1100			.83	.34	.15
1150			<u>.91</u>	.37	.15
1200			.98	.40	.15
1250			1.06	.43	.15
1300			1.14	.47	.18
1350			1.22	.50	.19
1400			1.30	.54	.19
1450			1.39	<u>.57</u>	.21
1500			1.48	.61	.21
1600				.69	.27
1700				.77	.28
1800				.85	.31
1900				.94	.36
2000				1.04	.36
2100				1.14	.40
2200				1.24	.44
2300				1.35	<u>.46</u>
2400				1.46	.52
2500				1.57	.55
2600					.58
2700					.65
2800					.68
2900					.73
3000					.78

DR	PR	F
32.5	125 PSI	.84
41	100 PSI	.785
51	80 PSI	.75
81	115 FH	.70
93.5	100 FH	.68
102	50 FH	.67

Table based on Hazen-Williams equation— $C_w = 150$

* To find function head loss in PVC pipe having a standard dimension ratio other than 21, the values in the table should be multiplied by the appropriate conversion factor (F) shown above.

Loss below bold line indicates velocities in excess of 5 feet per second. Velocities which exceed 5 feet per second are not recommended.



**FRICION LOSS CHARTS
FOR DIAMOND PIPE
IPS DIMENSION**

Q Gallons Per Min.	4-Inch	5-Inch	6-Inch	8-Inch	10-Inch	12-Inch
FRICION HEAD LOSS IN FEET PER HUNDRED FEET						
150	1.11					
160	1.26					
170	1.41					
180	1.57					
190	1.73					
200	<u>1.90</u>					
220	2.28	.81	.34	.09		
240	2.67	.95	.40	.10		
260	3.10	1.10	.46	.12		
280	3.56	1.26	.54	.14		
300	4.04	<u>1.43</u>	.61	.17		
320	4.56	<u>1.62</u>	.69	.19		
340	5.10	1.82	.77	.21		
360	5.67	2.02	.86	.24		
380	6.26	2.22	.95	.26		
400	6.90	2.45	1.04	.28	.10	
420		2.69	1.14	.31	.10	
440		2.92	<u>1.25</u>	.34	.11	
460		3.18	<u>1.35</u>	.37	.12	
480		3.44	1.46	.41	.14	
500		3.70	1.58	.43	.15	.060
550			1.89	.52	.18	.083
600			2.22	.61	.21	.096
650			2.58	.71	.24	.110
700			2.96	.81	.28	.125
750			3.36	<u>.93</u>	.32	.141
800			3.78	1.04	.36	.158
850			4.24	1.17	.40	.175
900	Table based on Hazen-Williams		4.71	1.30	.44	.194
950	equation— $C_w = 150$		5.21	1.44	.49	.213
1000			5.73	1.58	.54	.233
1050	1/ To find friction head loss in			1.73	.59	.254
1100	PVC pipe having a standard			1.88	.65	.276
1150	dimension ratio other than 21,			2.05	<u>.70</u>	.298
1200	the values in the table should			2.21	.76	.322
1250	be multiplied by the			2.39	.82	.346
1300	appropriate conversion factor			2.57	.88	.371
1350	(F) shown below:			2.76	.95	.397
1400				2.95	1.01	.423
1450				3.16	1.08	.451
1500				3.35	1.15	<u>.508</u>
1600					1.30	.568
1700					1.45	.632
1800					1.62	.698
1900					1.79	.767
2000					1.97	.840

SDR	PR	F
21	200 PSI	1.00
26	160 PSI	.91
32.5	125 PSI	.84
41	100 PSI	.785
51	80 PSI	.75
64	63 PSI	.71

Loss below bold line indicates velocities in excess of 5 feet per second.
Velocities which exceed 5 feet per second are not recommended.



FRICTION LOSS CHARTS FOR DIAMOND PIPE PIP DIMENSION

Q
Gallons 18" 21" 24" 27"
Per Min.

FRICTION HEAD LOSS IN FEET PER HUNDRED FEET

	5600	0.2724	0.1535	0.0943	
	5700	0.2815	0.1587	0.0974	
Table based on Hazen-Williams equation — $C_w = 150$	5800	0.2907	0.1638	0.1006	Table based on Hazen-Williams equation — $C_w = 150$
CONVERSION FACTORS FOR 18", 21", 24"	5900	0.3000	0.1691	0.1039	CONVERSION FACTORS FOR 27"
100FH-F = 1.00	6000	0.3095	0.1744	0.1071	80PSI-F = 1.00
115FH-F = 1.02	6100	0.3191	0.1799	0.1105	100PSI-F = 1.05
80PSI-F = 1.10	6200	0.3288	0.1854	0.1138	125PSI-F = 1.13
100PSI-F = 1.16	6300	0.3387	0.1909	0.1173	To find friction head loss in PVC pipe having a pressure rating other than 80PSI the values in the table should be multiplied by the appropriate conversion factor (F).
125PSI-F = 1.24	6400	0.3487	0.1966	0.1207	
To find friction head loss in PVC pipe having a pressure rating other than 100 FH the values in the table should be multiplied by the appropriate conversion factor (F).	6500	0.3589	0.2023	0.1242	
	6600	0.3692	0.2081	0.1278	
	6700	0.3796	0.2140	0.1314	
	6800	0.3901	0.2199	0.1351	
	6900	0.4008	0.2259	0.1387	
	7000	0.4116	0.2320	0.1425	
	7100	0.4226	0.2382	0.1463	
	7200	0.4336	0.2444	0.1501	
	7300	0.4449	0.2507	0.1540	
	7400	0.4562	0.2571	0.1579	
	7500	0.4677	0.2636	0.1619	
	7600	0.4793	0.2701	0.1659	
	7700	0.4910	0.2767	0.1700	
	7800	0.5029	0.2834	0.1741	
	7900		0.2902	0.1782	
	8000		0.2970	0.1824	
	8100		0.3039	0.1867	
	8200		0.3109	0.1909	
	8300		0.3180	0.1953	
	8400		0.3251	0.1997	
	8500		0.3323	0.2041	
	8600		0.3395	0.2085	
	8700		0.3469	0.2130	
	8800		0.3543	0.2176	
	8900		0.3618	0.2222	
	9000		0.3693	0.2268	
	9100		0.3770	0.2315	
	9200		0.3847	0.2362	
	9300		0.3924	0.2410	
	9400		0.4003	0.2458	
	9500		0.4082	0.2507	
	9600		0.4162	0.2556	
	9700		0.4242	0.2605	
	9800		0.4324	0.2655	
	9900		0.4406	0.2706	
	10000		0.4488	0.2757	
	10100		0.4572	0.2808	

18" PIP = 18.701" O.D.

21" PIP = 22.047" O.D.

24" PIP = 24.803" O.D.

27" PIP = 27.953" O.D.

Loss below bold line indicates velocities in excess of 5 feet per second.

Velocities which exceed 5 feet per second are not recommended.



**FRICION LOSS CHARTS
FOR DIAMOND PIPE
PIP DIMENSION**

Q
Gallons
Per Min.

6-Inch 8-Inch 10-Inch 12-Inch 15-Inch

FRICION HEAD LOSS IN FEET PER HUNDRED FEET

300	.89				
320	1.00				
340	1.12				
360	1.25				
380	1.38				
400	<u>1.52</u>				
420	1.66	.42	.14	.06	
440	1.81	.45	.15	.06	
460	1.96	.49	.17	.07	
480	2.13	.53	.18	.07	
500	2.29	.57	.19	.08	
550		.69	.23	.10	
600		.81	.27	.11	
650		<u>.93</u>	.31	.13	
700		1.07	.36	.15	
750		1.22	.41	.17	
800		1.37	.46	.19	
850		1.53	.52	.21	
900		1.71	.58	.24	
950		1.89	.64	.26	
1000		2.07	.70	.29	.12
1050			.77	.31	.12
1100			.83	.34	.15
1150			.91	.37	.15
1200			<u>.98</u>	.40	.15
1250			1.06	.43	.15
1300			1.14	.47	.18
1350			1.22	.50	.19
1400			1.30	.54	.19
1450			1.39	<u>.57</u>	.21
1500			1.48	.61	.21
1600				.69	.27
1700				.77	.28
1800				.85	.31
1900				.94	.36
2000				1.04	.36
2100				1.14	.40
2200				1.24	.44
2300				1.35	<u>.46</u>
2400				1.46	.52
2500				1.57	.55
2600					.58
2700					.65
2800					.68
2900					.73
3000					.78

DR	PR	F
32.5	125 PSI	.84
41	100 PSI	.785
51	80 PSI	.75
81	115 FH	.70
93.5	100 FH	.68
102	50 FH	.67

Table based on Hazen-Williams equation— $C_w = 150$

* To find function head loss in PVC pipe having a standard dimension ratio other than 21, the values in the table should be multiplied by the appropriate conversion factor (F) shown above.

Loss below bold line indicates velocities in excess of 5 feet per second. Velocities which exceed 5 feet per second are not recommended.



**FRICITION LOSS CHARTS
FOR DIAMOND PIPE
PIP DIMENSION**

Q Gallons Per Min.	18"	21"	24"	27"	
	FRICITION HEAD LOSS IN FEET PER HUNDRED FEET				
	1000	0.0251	0.0112	0.0063	0.0039
	1100	0.0299	0.0134	0.0076	0.0046
	1200	0.0351	0.0158	0.0089	0.0055
	1300	0.0407	0.0183	0.0103	0.0063
	1400	0.0467	0.0210	0.0118	0.0073
	1500	0.0531	0.0238	0.0134	0.0082
	1600	0.0598	0.0268	0.0151	0.0093
	1700	0.0669	0.0300	0.0169	0.0104
	1800	0.0744	0.0334	0.0188	0.0116
	1900	0.0822	0.0369	0.0208	0.0128
	2000	0.0904	0.0405	0.0229	0.0140
	2100	0.0989	0.0444	0.0250	0.0154
	2200	0.1078	0.0484	0.0273	0.0167
	2300	0.1171	0.0525	0.0296	0.0182
	2400	0.1266	0.0568	0.0320	0.0197
	2500	0.1366	0.0613	0.0345	0.0212
	2600	0.1469	0.0659	0.0371	0.0228
	2700	0.1575	0.0706	0.0398	0.0245
	2800	0.1684	0.0756	0.0426	0.0262
	2900	0.1797	0.0806	0.0454	0.0279
	3000	0.1914	0.0859	0.0484	0.0297
	3100	0.2033	0.0912	0.0514	0.0316
	3200	0.2156	0.0967	0.0545	0.0335
	3300	0.2283	0.1024	0.0577	0.0354
	3400	0.2412	0.1082	0.0610	0.0375
	3500	0.2545	0.1142	0.0644	0.0395
	3600	0.2681	0.1203	0.0678	0.0416
	3700	0.2821	0.1265	0.0713	0.0438
	3800	0.2963	0.1329	0.0749	0.0460
	3900	0.3109	0.1395	0.0786	0.0483
	4000	0.3258	0.1462	0.0824	0.0506
	4100	0.3411	0.1530	0.0862	0.0530
	4200	0.3566	0.1600	0.0902	0.0554
	4300	0.3725	0.1671	0.0942	0.0578
	4400	0.3887	0.1744	0.0983	0.0604
	4500	0.4052	0.1818	0.1025	0.0629
	4600	0.4220	0.1893	0.1067	0.0655
	4700	0.4391	0.1970	0.1110	0.0682
	4800	0.4565	0.2048	0.1154	0.0709
	4900	0.4743	0.2128	0.1199	0.0737
	5000	0.4924	0.2209	0.1245	0.0765
	5100	0.5107	0.2291	0.1291	0.0793
	5200	0.5294	0.2375	0.1339	0.0822
	5300	0.5484	0.2460	0.1387	0.0852
	5400	0.5677	0.2547	0.1436	0.0882
	5500	0.5873	0.2635	0.1485	0.0912

Table based on Hazen-Williams equation — $C_w = 150$

CONVERSION FACTORS
FOR 18", 21", 24"

100FH-F = 1.00
115FH-F = 1.02
80PSI-F = 1.10
100PSI-F = 1.16
125PSI-F = 1.24

To find friction head loss in PVC pipe having a pressure rating other than 100FH the values in the table should be multiplied by the appropriate conversion factor (F)

CONVERSION FACTORS
FOR 27"

80PSI-F = 1.00
100PSI-F = 1.05
125PSI-F = 1.13

To find friction head loss in PVC pipe having a pressure rating other than 80PSI the values in the table should be multiplied by the appropriate conversion factor (F)

18" PIP = 18.701" O.D.

21" PIP = 22.047" O.D.

24" PIP = 24.803" O.D.

27" PIP = 27.953" O.D.

Loss below bold line indicates velocities in excess of 5 feet per second.

Velocities which exceed 5 feet per second are not recommended.



FRICTION LOSS CHARTS FOR DIAMOND PIPE PIP DIMENSION

Q
Gallons Per Min. 18" 21" 24" 27"

FRICTION HEAD LOSS IN FEET PER HUNDRED FEET

	5600	0.2724	0.1535	0.0943	
	5700	0.2815	0.1587	0.0974	
Table based on Hazen-Williams equation — $C_w = 150$	5800	0.2907	0.1638	0.1006	Table based on Hazen-Williams equation — $C_w = 150$
CONVERSION FACTORS FOR 18", 21", 24"	5900	0.3000	0.1691	0.1039	CONVERSION FACTORS FOR 27"
100FH-F = 1.00	6000	0.3095	0.1744	0.1071	80PSI-F = 1.00
115FH-F = 1.02	6100	0.3191	0.1799	0.1105	100PSI-F = 1.05
80PSI-F = 1.10	6200	0.3288	0.1854	0.1138	125PSI-F = 1.13
100PSI-F = 1.16	6300	0.3387	0.1909	0.1173	To find friction head loss in PVC pipe having a pressure rating other than 80PSI the values in the table should be multiplied by the appropriate conversion factor (F).
125PSI-F = 1.24	6400	0.3487	0.1966	0.1207	
To find friction head loss in PVC pipe having a pressure rating other than 100 FH the values in the table should be multiplied by the appropriate conversion factor (F).	6500	0.3589	0.2023	0.1242	
	6600	0.3692	0.2081	0.1278	
	6700	0.3796	0.2140	0.1314	
	6800	0.3901	0.2199	0.1351	
	6900	0.4008	0.2259	0.1387	
	7000	0.4116	0.2320	0.1425	
	7100	0.4226	0.2382	0.1463	
	7200	0.4336	0.2444	0.1501	
	7300	0.4449	0.2507	0.1540	
	7400	0.4562	0.2571	0.1579	
	7500	0.4677	0.2636	0.1619	
	7600	0.4793	0.2701	0.1659	
	7700	0.4910	0.2767	0.1700	
	7800	0.5029	0.2834	0.1741	
	7900		0.2902	0.1782	
	8000		0.2970	0.1824	
	8100		0.3039	0.1867	
	8200		0.3109	0.1909	
	8300		0.3180	0.1953	
	8400		0.3251	0.1997	
	8500		0.3323	0.2041	
	8600		0.3395	0.2085	
	8700		0.3469	0.2130	
	8800		0.3543	0.2176	
	8900		0.3618	0.2222	
	9000		0.3693	0.2268	
	9100		0.3770	0.2315	
	9200		0.3847	0.2362	
	9300		0.3924	0.2410	
	9400		0.4003	0.2458	
	9500		0.4082	0.2507	
	9600		0.4162	0.2556	
	9700		0.4242	0.2605	
	9800		0.4324	0.2655	
	9900		0.4406	0.2706	
	10000		0.4488	0.2757	
	10100		0.4572	0.2808	

18" PIP = 18.701" O.D.

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24" PIP = 24.803" O.D.

27" PIP = 27.953" O.D.

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8/05