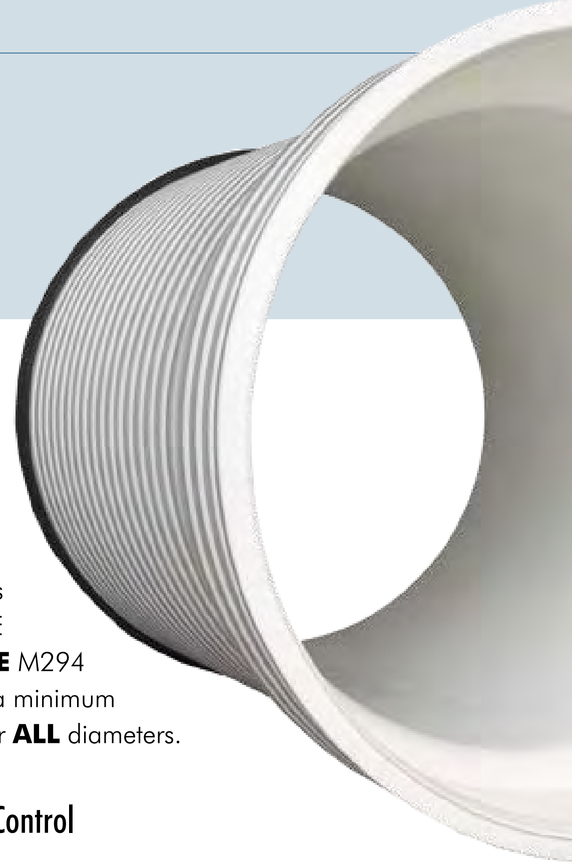
CONTECH®
CONSTRUCTION PRODUCTS INC.

A-2000™ / D-2000™ PVC Pipe for Storm Sewers and Drainage

Knowledge. Solutions. Service.

Selecting Performance Storm Sewers and Drainage Systems



Drainage systems are required to meet multiple criteria. The choice of a particular material depends upon a number of factors; however, the best choice is the one that yields the best performance over the project life cycle.

Thermoplastic Storm Sewer and Drainage Pipe

In recent years, the use of thermoplastic pipe for stormwater drainage systems has gained wide acceptance—based upon performance and economic advantages when contrasted with more conventional drainage pipe materials. **However, when it comes to performance, not all thermoplastic storm sewer pipes are equal.** There are distinct differences between A-2000/D-2000 Polyvinyl Chloride (PVC) drainage pipe and other drainage pipes that can affect overall pipe system performance.

CONTECH® A-2000 PVC Drainage Pipe:

Available in Diameters 4"-36" and 12.5', 14' and 22' lengths.

Originally developed in the early 1980's, A-2000 has built an outstanding performance history that's setting the standard for gravity flow, sanitary sewer applications. The material advantages offered by PVC—plus the innovative, double wall design with the unique, patented gasketed joint system—makes A-2000 and more recently D-2000 the ideal choice for stormwater drainage systems. Now you can have all of the advantages without the limitations of AASHTO M294 corrugated HDPE (M294 HDPE pipe) or reinforced concrete pipe.

18" PVC – HDPE Wall Sections

Compact A-2000 PVC profile is stable and not subject to local buckling like M294 HDPE pipe.

Strength

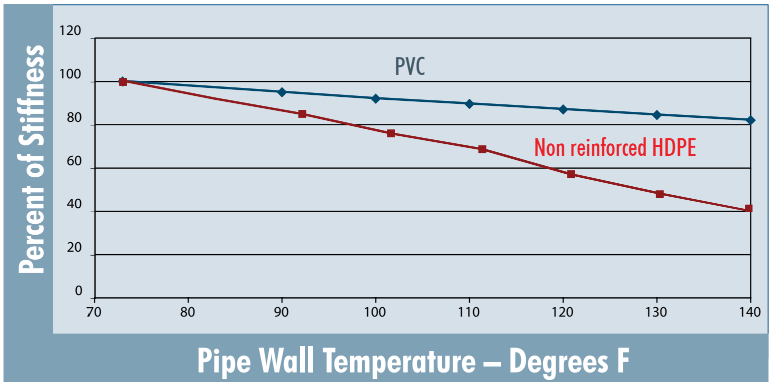
CONTECH's PVC compound provides **6 times** greater long-term material stiffness as compared to HDPE resin. And **UNLIKE** M294 HDPE pipe, it has a minimum 46 pipe stiffness for **ALL** diameters.

Better Deflection Control

Minimum Specified Pipe Stiffness (73°)

Pipe Diameter	PVC ASTM F949	Corrugated AASHTO M294
12	46	50
15	46	42
18	46	40
24	46	34
30	46	28
36	46	22

Pipe Stiffness Retention vs. Temperature



When compared to other thermoplastic pipes on the market, A-2000 stands up to the test. In fact, it comes out on top.

When installed in accordance with ASTM D2321, A-2000 provides excellent shape control (performance). Simple surface temperature measurements on sun-exposed pipe surfaces indicate that under normal temperatures, black M294 HDPE pipe approaches 140°F, while lighter color white pipe reaches temperatures in the range of 120°F. The difference between effective pipe stiffness of PVC and M294 HDPE pipe during construction on a summer day can result in A-2000 being as much as **3 TIMES STIFFER**. This significant stiffness advantage means A-2000 can be installed with conventional flexible pipe practice and not experience excessive shape distortions - lowering installation cost.

Heights of Cover

Based on research done under the National Cooperative Highway Research Program, AASHTO has revised its plastic pipe design methods. AASHTO Section 12 designs now include wall profile stability, soil arching and deflection as design considerations. Unstable wall profiles will fail due to local buckling rather than by ring compression or ring buckling. This research demonstrates that A-2000 profile walls are stable while others, like those used for M294 HDPE pipe, are not.

When selecting a system based on pipe stiffness, material strength and structural capability, A-2000 PVC far exceeds the performance characteristics of M294 HDPE pipe.

A comparison of cover heights using AASHTO design methodology and H20 live loading for A-2000 and a major manufacturer's M294 HDPE pipe are summarized below.

A-2000 vs. M294 HDPE Heights of Cover

Pipe Type/ Specification	Allowable Ht. of Cover	Allowable Structural Backfill	Min. Compaction	Min. Trench
PVC A-2000 - ASTM F949	1'-20'	A1A, A1, A3 A2-4, A2-5	90%	1.5 X O.D. +12"
	21'-35'	A1A, A1, A3	95%	1.5 X O.D. +12"
AASHTO M294 HDPE	1'-10'	A1A, A1, A3	95%	O.D. + 36"
	11'-20'	A1A	95%	3.0 x O.D.
	21'-35'	Not Allowed		

Hydraulic Efficiency

PVC vs. Concrete Pipe

Thermoplastic pipes, with smoother interiors and fewer joints, reduce resistance to flow and are hydraulically more efficient than conventional (i.e. RCP) storm drainage pipe materials. Flow testing conducted in 2002 by the Utah Water Research Laboratory concluded A-2000 PVC Pipe, with its inner wall formed over a polished mandrel, has the lowest wall friction factor (Manning's "n" = .009) of any thermoplastic pipe available and offers real advantages compared to RCP (n = .012- .013). This added efficiency means A-2000 can be designed as a smaller and less expensive pipe, with less excavation due to flatter pipe slopes and less manhole/junction box depth requirements.

PVC vs. Corrugated HDPE Pipe

Hydraulic tests performed at a major United States Water Research Laboratory led researchers to conclude that corrugated M294 HDPE pipe's "n" factor varied "depending upon the smoothness of the liners" and "the bonding of the liner to the corrugations made the pipe interior somewhat wavy." Once installed, corrugated M294 HDPE pipe walls are subject to local buckling (NCHRP Report 438) and the measured waviness increases with load. Using the method derived to estimate the effective Manning's "n" factor, Manning's "n" values of 0.017-0.022 provide a more accurate representation of M294 HDPE pipe's hydraulic efficiency when in-service and under load.

A-2000 PVC pipe, with its engineered, stable profile, is designed to eliminate local buckling.

A-2000 PVC pipe has a smooth, glossy interior for uninterrupted flow.

Durability, Service Life

PVC materials used in the manufacture of gravity flow pipe offer excellent resistance to conventional corrosion and abrasion. In fact, profile wall PVC pipe has been shown to have better abrasion resistance than reinforced concrete pipe in side-by-side laboratory testing at California State University.

PVC and M294 HDPE pipe do **not** provide equal long-term durability performance. Under loading or localized tensile stress, M294 HDPE pipe is subject to environmental stress cracking—also known as slow crack growth.

PVC pipe is not threatened by this type of cracking. When you consider durability and service life, A-2000 PVC far exceeds the performance characteristics of M294 HDPE pipe. (See the National Cooperative Highway Research Program study conducted by Drexel University, March, 1999: "HDPE Pipe: Recommended Material Specifications and Design Requirements".)

The Need for Tight Joints

Storm sewers have always presented special needs for tight jointing systems. Because of their function, they are subject to rapidly changing flow levels. The sudden rise and fall of flow levels leaves storm sewers susceptible to backfill migration into the sewer unless tight joints are used. This loss of backfill reduces the soil support of the pipe and causes settlement at the surface. Where storm sewers are below the existing water table, water tight joints are needed to prevent infiltration and maintain storm sewer capacity.

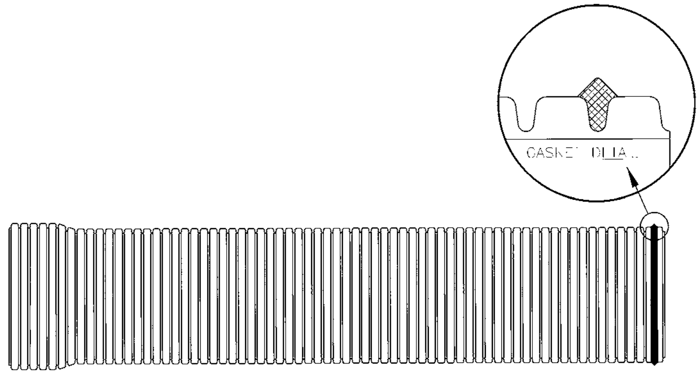
A-2000's long, 22' lengths and soil/water tight joints clearly make it the preferred choice with regard to system tightness. In comparison, RCP has shorter lengths and more joints. RCP joints are also often mortared or "mudded in" vs. watertight gasketed joints, which can lead to future service problems as cracking at the seams/joints permits water and soil migration and eventual settlement. And with A-2000 you don't have to specify special jointing requirements – watertight gasketed joints are standard with A-2000.

Handling and Installation

A-2000's easy handling weight and the availability of up to 22' lay lengths often result in reduced labor costs and more economical installation. Compared to heavy-weight and short-length RCP, PVC can be installed with greater ease and lower cost. And, contrasted to M294 HDPE pipe, PVC has added beam strength—which means better line and grade control, increasing crew efficiency. Plus, PVC requires less trench width, lowering excavation costs and speedy installation.

The Performance Choice

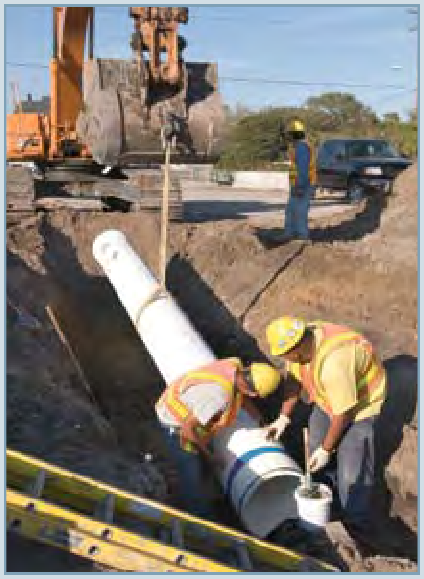
With the increasing demands on our drainage and storm sewer systems, products designed and proven to provide the best performance over the project life cycle are needed. A-2000 PVC drainage pipe offers all of the initial cost advantages associated with thermoplastic pipe when compared with RCP but without the performance limitations of corrugated M294 HDPE pipe. There's no reason to compromise on performance—**Select A-2000 PVC: The Best Storm Sewer and Drainage Pipe on the Planet.**



CONTECH's A-2000 PVC pipe is lightweight and easy to handle.

Best Pipe on the Planet

The New D-2000



Responding to customer demand, CONTECH has introduced its latest solution for the small diameter drainage market. D-2000 PVC pipe, available in 4"-36" diameters, answers the need for a high performance PVC drainage pipe at a price that is more competitive with corrugated M294 HDPE pipe. D-2000 is manufactured to meet and exceed the minimum pipe stiffness requirements of AASHTO M304 (vs. ASTM F949 for A-2000), resulting in a lighter weight, lower cost PVC pipe. Don't be fooled, D-2000 still offers many performance advantages over M294 HDPE including:

- Higher effective pipe stiffness on warm, sunny days, resulting in superior deflection control and simplified installation procedures.
- Cover limits ranging from 12 inches minimum to over 20 feet maximum.
- Greater beam strength for improved line and grade control.
- Smoother interior wall for improved hydraulic capacity.
- Superior short-term and long-term inground joint tightness - where it counts.
- Improved post installation test results (deflection, air and laser testing).

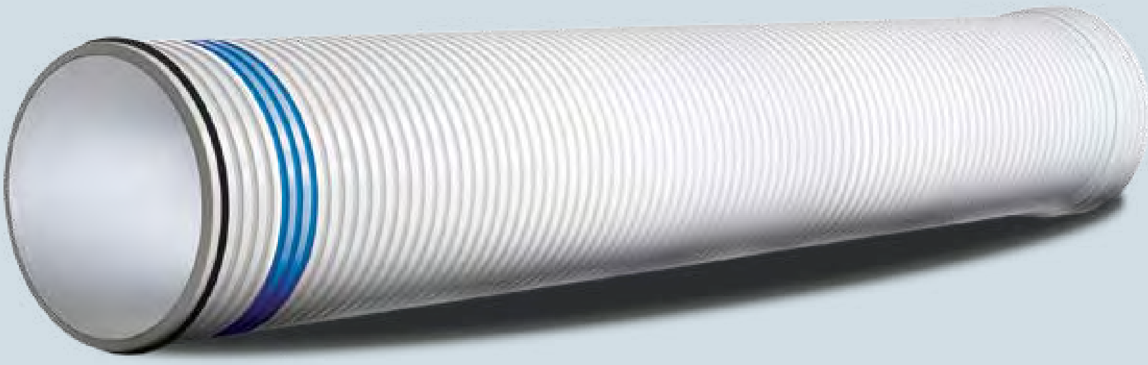
D-2000 Mechanical Properties

INITIAL			
Cell Class	Minimum Tensile Strength	Minimum Modulus of Elasticity	
12454	7,000 PSI	400,000 PSI	
12364	6,000 PSI	440,000 PSI	
50 YEAR			
Cell Class	Minimum Tensile Strength	Minimum Modulus of Elasticity	Allowable Long-Term Strain
12454	3,700 PSI	140,000 PSI	5%
12364	2,600 PSI	158,400 PSI	3.5%
100 YEAR			
Cell Class	Minimum Tensile Strength	Minimum Modulus of Elasticity	Allowable Long-Term Strain
12454	3,620 PSI	125,600 PSI	5%

D-2000 Section Properties

Size (in)	Inside Dia. (in)	Outside Dia. (in)	Area (in^2/foot)	C*	I (in^4/in)	PSI (min)
4	3.95	4.29	0.702	0.106	0.00021	46
6	5.88	6.41	0.876	0.161	0.00070	46
8	7.87	8.59	1.18	0.218	0.00175	46
10	9.84	10.78	1.48	0.394	0.00359	46
12	11.72	12.80	1.80	0.325	0.00603	46
15	14.37	15.66	1.90	0.397	0.00957	38
18	17.61	19.15	1.99	0.516	0.01314	32
24	23.53	25.58	2.68	0.680	0.03195	24
30	29.47	32.15	3.96	0.813	0.08372	19
36	35.48	38.74	4.74	0.992	0.14606	16

* Extreme fiber distance from neutral axis.



Additional A-2000 Products and Applications

A-2000 for Roof Drainage Systems

Managing large volumes of stormwater runoff from roof areas of industrial, commercial and warehouse facilities is more demanding than for most gravity-fed sewer systems. Additionally, intense rainfalls, combined with added building height, can create hydrostatic pressures within the pipe as well as on the joints and other system components. To handle these requirements, you need the higher strength and joint tightness of A-2000 PVC drainage pipe. CONTECH's full line of readily-available adapters and fittings makes connecting downspouts and laterals simple. Because of the unique gasket and bell design, there is no field beveling required.

A2™ Liner Pipe for Trenchless Rehabilitation

Renew the performance of your aging underground infrastructure with A2 Liner Pipe—the proven, trenchless solution to sliplining existing sewers and culverts. Using the double wall A-2000 design, CONTECH developed A2 Liner Pipe for sliplining deteriorating pipelines where open trenching is not practical or desirable. You can install A2 Liner Pipe in diameters ranging from 12"-36" and in lengths from 2.5' to 20'—speeding installation. And because of its light weight, you can use smaller, less expensive equipment for installation—reducing costs.

A-2000 Perforated Pipe for Subdrainage Systems

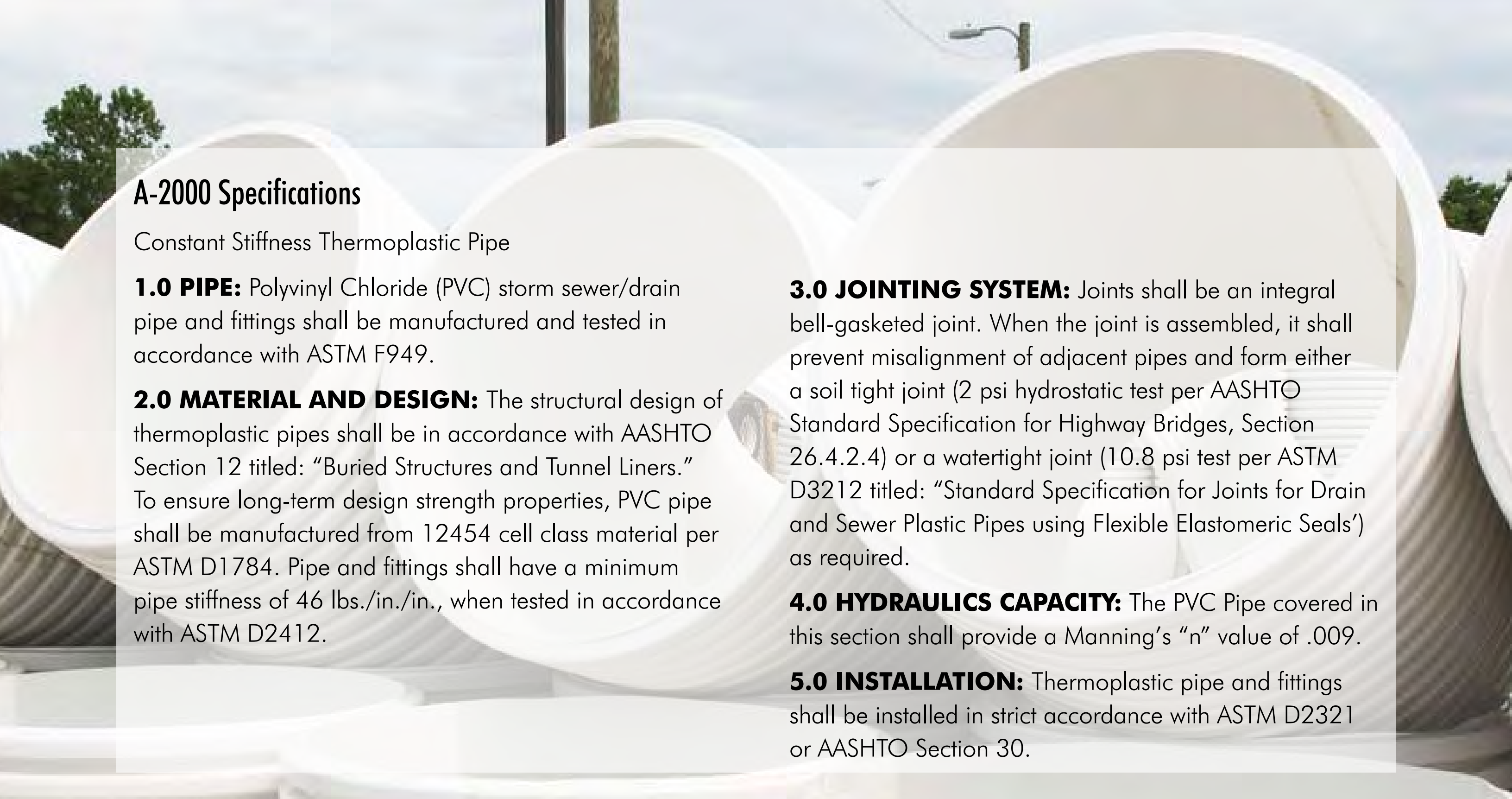
CONTECH A-2000 offers several critical features and benefits that make it the performance choice for subsurface drainage systems:

- 46 psi pipe stiffness for structural stability and improved deflection control.
- Glossy smooth interior for improved hydraulic capacity.
- PVC rigidity that provides essential beam strength for improved line and grade control during installation.
- Positive-gasketed jointing system.

Standard perforations for 4"-18" diameters are slots, while perforations for pipe sizes 21"-36" are circular $^{3}/_{8}$" diameter (.375") holes. Fully perforated A-2000 is also available for even greater open area.

Perforation Dimensions

Pipe Size (in)	Slot Dimension/Hole Size (in) (min)	Centers (in)	Perforation Open Area (in^2/LF)
4	1.062L x 0.031W	0.42	1.90
6	1.375L x 0.031W	0.52	1.98
8	1.750L x 0.031W	0.69	1.90
10	2.187L x 0.031W	8.83	1.98
12	1.687L x 0.051W	1.03	2.00
15	1.250L x 0.051W	1.38	2.00
18	2.250L x 0.051W	1.38	2.00
21	0.375 Diameter	1.60	3.30
24	0.375 Diameter	1.90	2.70
30	0.375 Diameter	2.32	2.20
36	0.375 Diameter	2.61	2.00



A-2000 Specifications

Constant Stiffness Thermoplastic Pipe

1.0 PIPE: Polyvinyl Chloride (PVC) storm sewer/drain pipe and fittings shall be manufactured and tested in accordance with ASTM F949.

2.0 MATERIAL AND DESIGN: The structural design of thermoplastic pipes shall be in accordance with AASHTO Section 12 titled: "Buried Structures and Tunnel Liners." To ensure long-term design strength properties, PVC pipe shall be manufactured from 12454 cell class material per ASTM D1784. Pipe and fittings shall have a minimum pipe stiffness of 46 lbs./in./in., when tested in accordance with ASTM D2412.

3.0 JOINTING SYSTEM: Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2 psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8 psi test per ASTM D3212 titled: "Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals') as required.

4.0 HYDRAULICS CAPACITY: The PVC Pipe covered in this section shall provide a Manning's "n" value of .009.

5.0 INSTALLATION: Thermoplastic pipe and fittings shall be installed in strict accordance with ASTM D2321 or AASHTO Section 30.

CONTECH Construction Products Inc. provides site solutions for the civil engineering industry. CONTECH's portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control and soil stabilization products.

For more information, call one of CONTECH's Regional Offices located in the following cities:

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