CPP Plastic Highway Culverts and Corrosion Resistant Gravity Drain Pipe Systems

Highway Culverts

- Airport Runway/Parking Lot Golf Course Storm Drains
- Storm Water Applications
- Industrial Waste Water Applications
- Constructed Wetlands
- Landfill Drainage
- Sewer Sludge Compost Pipe
- Sand Filters

Septic Systems

Crumpler Plastic Pipe, Inc.

Manufacturers of Corrugated Plastic Drainage Pipe

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CRUMPLER PLASTIC PIPE Inc
CPP
CORRUGATED PLASTIC PIPE

C-00 Rev. 4/22

Corrosion Resistant Gravity Drain Pipe and Culverts

A LOAD BEARING ENVELOPE COMPACTED AROUND CPP PIPES PROVIDES H-25 CULVERT PIPE STRUCTURES

H-25 EQUALS 32,000 lbs. PER AXLE

INTRODUCTION

CPP offers TWO TYPES of High Density Polyethylene (HDPE) Corrugated Plastic Pipes for NON-PRESSURE, GRAVITY DRAIN, CORROSION RESISTANT applications. These are CPP'S SINGLE-WALL corrugated and CPP'S SMOOTH-CORE/n-10 corrugated with a DOUBLE WALL profile.

Both SINGLE-WALL and DUAL WALL SMOOTH-CORE/n-10 can be used in designing engineering solutions to a variety of Culvert-Storm Sewer and Waste-Water Treatment applications as well as Commercial Landscaping or Agricultural Controlled Drainage with Sub Surface Irrigation.

CPP'S DUAL WALL SMOOTH-CORE/n-10 corrugated pipe with a SMOOTH INTERIOR LINER is used in situations where the HIGH-FULL-FLOW capacity of each size is required to convey a High Surge water release, and in applications of little or no grade. It is used in state and federal highway construction projects. The improved water flow rates makes downsizing possible in some situations. The Anti-Adhesive, Non-Polar, Slick Surface nature of the HDPE plastic raw material minimizes solid waste build up, and thus reduces cleaning maintenance costs.

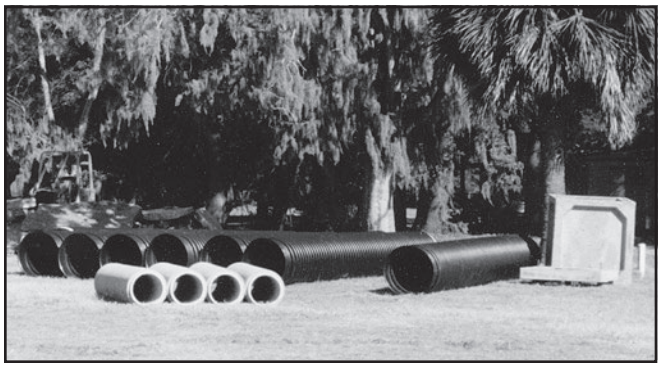
HDPE is the MOST CHEMICALLY INERT of all plastic raw material. HDPE makes CPP'S SINGLE-WALL and DUAL WALL SMOOTH-CORE/n-10 pipes resistant to the combined effects of Sand – Gravel – Sediment ABRASION, and its consequent effects of CORROSION. CORROSION often causes other pipe materials to fail before the installed pipe system is fully depreciated. Engineers have specified HDPE pipes for years in chemically active ALKALINE or ACIDIC site conditions where traditional pipe materials will rust out or collapse from an ever THINNING pipe wall caused by the CORROSION inducer of Sand – Gravel – Sediment ABRASION that is often suspended in FLASH FLOOD water surges.

Wet Weather Storm Water Applications

Industrial and Wastewater Applications

A storm water discharge is defined by the US Environmental Protection Agency (EPA) as rainwater or snow-melt run off. These fresh waters become polluted as they flow over modern man-made structures like roads, parking lots, industrial sites, roofs, suburban lawns, farm land, etc. An abundance of suspended pollutants can easily ride piggy back on sediment particles in such water flows. These polluted waters are a known contributor to poor water quality levels in receiving streams that suffer fish kills, and other environmentally harmful side effects. To better control non-point source storm-water run-off pollution, the EPA has extended its rules to cover any parcel of disturbed land of three acres or more. The initial run-off of storm water contains highly concentrated road salts, calcium chloride, motor oil, fuel and other corrosive chemicals that effect storm sewer pipes according to the water's acidity or alkalinity. CRUMPLER'S inert HDPE corrugated plastic pipes will not react with this potent "first-flush" storm water. The chemical resistance of CPP'S SINGLE-WALL and DUAL WALL SMOOTH-CORE/n-10 pipes makes them ideal for the use in SALTWATER environments and other storm water systems as they not only eliminate "INTERNAL" pipe wall CORROSION, but also eliminate the "EXTERIOR" pipe wall CORROSION caused by CORROSIVE SOILS. The need to remove untreated, unwashed, corrosive natural soils from the pipe trench site, and import non-corrosive off-site backfill is eliminated. LABOR IS THE LARGEST COST COMPONENT IN ANY BURIED PIPE SYSTEM; EXTRA LABOR caused by the removal of corrosive trench site soil can make contract bid work in these areas a non-option. CPP pipes also meet the corrosion needs in snowbelt areas that must endure much winter road and parking lot salt-melt run off.

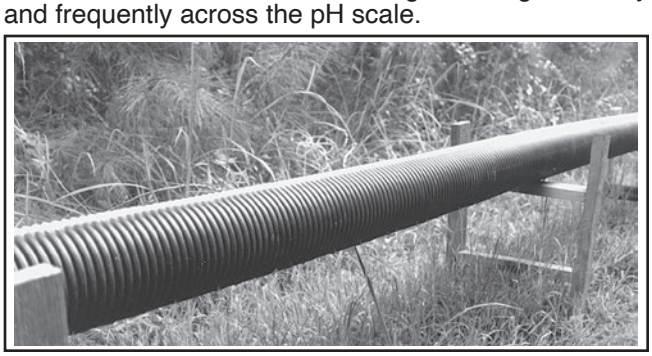
Road Culverts
Highway Slope & Edge Shoulder Drains
Parking Lot Storm Drains
Airport Runway Shoulder & Edge Storm Drains
Cul-de-Sac Storm Drains
Storm Sewer Flood Control Retention Beds & Ponds
Salt-Water Exfiltration Storm Sewers
Golf Course Storm & Culvert Drains
Pedestrian Bridges for Parks & Side Walks
Foundation-Gutter Storm Drains
Construction De-Watering
Farm Pond Water Transfer
Catfish-Crawfish Water Control Systems
Gated Furrow/Bubble Irrigation Pipe Systems



CPP Pipes have been used in conjunction with culverts and structures of other raw material bases since 1985 to engineer longer lasting pipe systems.

Chemical Filtration Pebble Beds
Car Wash Treatment Retention Beds
Brine Water Treatment Systems
Pulp & Paper Mill Water Treatment Systems
Mining & Water Pollution Control Systems
(SF) - Sub-Surface Flow Wetlands
(FWS) - Free Water Surface Sloughs
Waste Water Treatment Controlled Release Lagoons
Land Fill Drainage
Waste Water Treatment Plant Discharge Lines
Septic Systems
Animal Waste-Water Treatment Systems
Sand Filters
Municipal Sewer Leachate Media Filter Pipes
Municipal Sewer Sludge Composting Systems

CORROSIVE waste-water treatment pipe systems can look forward to a longer life with CPP'S HDPE corrugated pipes as well. Highly CORROSIVE sanitary sewage concentrated with caustic lyes, household detergents, brighteners and bacterial elements have made CPP'S HDPE corrugated pipes desirable for use in sewer plant filtration treatment beds and sand filters. These HDPE Raw Material based pipes will not pit or deteriorate due to CORROSIVE gases or liquids. At points where topography and grade conspire to create a sewer flooding back-up overflow into an adjacent storm sewer system, these chemically inert pipes do not release additional chemicals along with the chemical treatment flush that is added to sanitize storm sewers contaminated with raw sewage back-up. Consequently, local receiving waters are not further harmed with toxins. In industrial waste water releases, the common practice of dosing or diluting CORROSIVE fluids with water to make the effluent less harmful to the pipe wall is not necessary; also supplemental coatings, plastic film envelopes or cathodic protection systems are not needed with CPP'S SINGLE-WALL or DUAL WALL SMOOTH-CORE/n-10 corrugated pipes; in addition, labor intensive, field applied protective coatings are not needed for a corrosive free coupling. CPP offers a variety of non-pressure, gravity flow leak resistant couplers that should be considered for use in chemically active fluid transportation pipe systems. Leak resistant couplers are also a must consideration in farm pond/storm water retention pipe systems that are generally embedded at non- cohesive soil sites. CPP CORROSION RESISTANT pipes are also used in landfill leachate treatment pipe systems because landfill leachate flow strengths change radically and frequently across the pH scale.



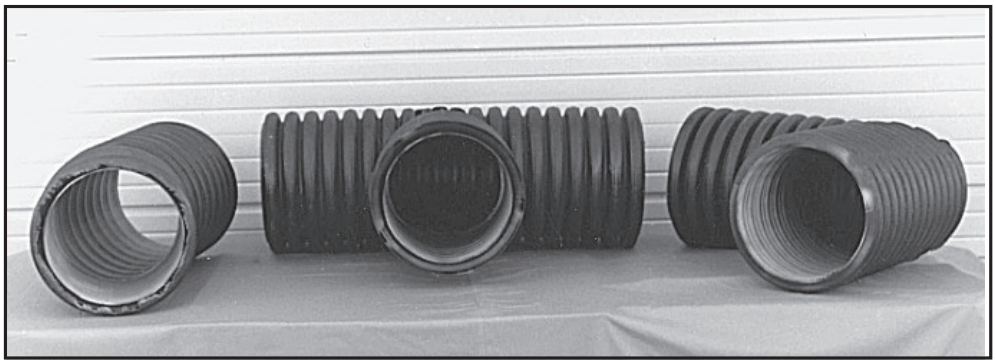
CPP'S Dual and Single Wall pipes are used in surface and sub-surface, natural or built-up wetlands, and sand-pebble filters for low cost small community waste water treatment systems. Sand Filter and built-up constructed wetland diagrams shown on pages 26 and 27.

Engineered Fittings For Different Applications

The LIGHT WEIGHT of CPP'S corrugated pipes enables installation costs to be cut significantly because smaller crews and less expensive excavation machines can be used. Long twenty-foot lengths mean fewer joints and faster assembly with a durable plastic product. The SMOOTH-LINER in the SMOOTH-CORE version adds strength, and prevents snaking during the installation of this style. Both SINGLE-WALL and DUAL WALL SMOOTH-CORE/n-10 can be installed to withstand H-20 TRAFFIC BEARING LIVE LOADS under TWELVE inches of cover or up to TWENTY feet deep if backfill conforms to ASTM-D-2321 and compacted per AASHTO-T-99.

LARGE & SMALL CATCH BASINS AVAILABLE

Engineers have specially designed deep depth projects with CPP by specifying the use of high-end quality backfill materials and 95% proctor density compaction in an expanded fabric wrapped gravel-envelope backfill zone. Other installation references are ASTM-F-449 and ASAE-EP-260.3. Paving over pipes with asphalt or concrete eliminates pipe deflection to virtually zero. To protect CPP pipes during construction prior to pavement placement from construction loads that may exceed H-25 loading, the MOUNDING of three feet of fill over pipes should be employed at construction site crossovers. The mounding ramp should extend to each side of the pipe for a distance of 1.5 times the diameter plus twelve inches. These same MOUNDING requirements are also specified by State DOT's for culverts made of concrete or metal.



Fabricated fittings can be provided to meet specific job site needs.

OTHER USES

Radon Gas Relief
Tubular Concrete Forms
Electrical Conduit
Relining Corrosion Worn Pipes

Low Pressure Industrial Vacuum Hose

Delivery Inspection

Crumpler Plastic Pipe, Inc. makes every effort to ensure order accuracy and quality. As a final check, the customer should conduct a personal inspection at delivery to verify that the correct product and the expected quantity is received. Pipe corrugations, gaskets, pipe ends, couplers or other joints, and any accessories should be visually inspected for damage that may have occurred during shipment.

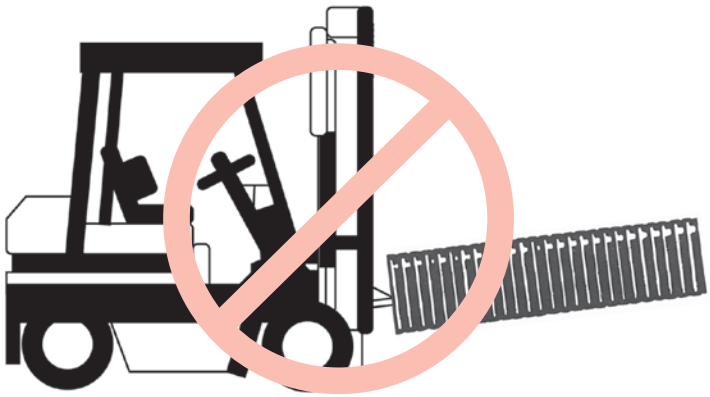
Product Identification

Product markings on Crumpler Plastic Pipe will include the following information to facilitate jobsite inspection.

- Nominal pipe size
- Manufacturer's name
- Date code
- Applicable standard(s)

Unloading

The contractor should set aside an areafor construction site storage. This area should be flat, free of large rocks, debris, and rough surfaces. It should also be out of the way of construction traffic. Depending on the pipe size and quantity of product, pipes may be unloaded with a backhoe, forklift, or other equipment using a nylon sling or cushioned cable. Lift slings should be wrapped around the pipes at the THIRD POINTS as the pipes are lifted off the delivery trailer onto the ground. Also, some pipe stacked low, as on a drop deck equipment trailer, may be carefully rolled onto a forklift and then placed on the ground. However, forklift end handling must not be employed as the forks will damage the pipe's interior walls.



End handling with a forklift **MUST NOT** be used as pipe damage will occur. Due to joint weight, larger diameter pipes should not be off loaded by hand.

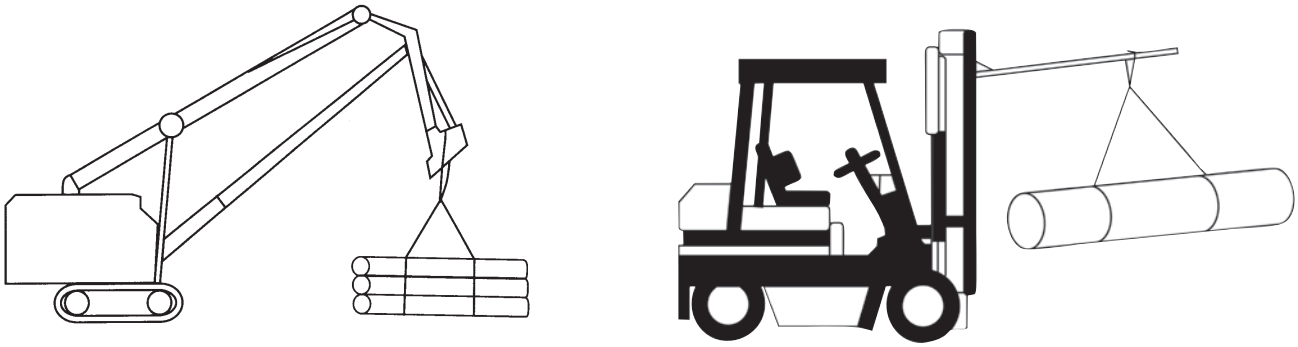
WEIGHT OF INDIVIDUAL JOINTS OF PIPE

Pipe Dia.	Length	Weight
12"	20'	70 lbs.
15"	20'	107 lbs.
18"	20'	150 lbs.
24"	20'	235 lbs.
30"	20'	300 lbs.
36"	20'	360 lbs.
42"	20'	470 lbs.
48"	20'	680 lbs.

NOTE: SIZE 15" TO 24" DRIVEWAY CULVERTS ARE AVAILABLE IN 24' OR 30' LENGTHS

Job Site Storage

Figure 1: Pipe Handling



Reasonable care should be used in handling pipe. The pipe should not be dropped, dragged or bumped against other pipe or objects. Palletized pipe should remain in the pallet for jobsite storage. Non-palletized pipe can be stockpiled for temporary storage in a flat debris-free area out of the way of construction traffic. Begin the stockpile with secured timbers spaced the width of the proposed stockpile at a distance not exceeding the third points. For pipe with attached bells, a recommended stacking method is to alternate the direction of the pipe lengths so that the bells are not stacked on each other. As shown in Figure 2, up to three pipes can be laid before alternating directions. Subsequent layers should follow the same pattern as the first but with fewer sticks of pipe in each row. For smooth interior pipe, storage space can be minimized by nesting smaller diameters into larger diameter pipe. Factory installed gaskets on the spigot should be protected by positioning them between corrugations.

CPP Return Policy

All returned pipe and fittings are subject to a 10% restocking charge. Prior to any refunds, pipe must be inspected for damage by a representative of Crumpler Plastic Pipe, Inc. There will be no refunds issued on damaged goods. Customer is liable for freight back to CPP. No returns accepted after 90 days from invoice date.

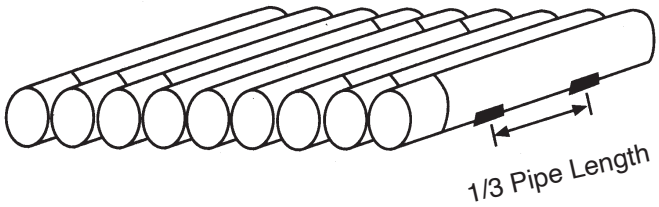


Figure 2: Stockpiling for Bell & Spigot, First Layer

Stringing the Pipe

Placing the pipe and accessories along the open trench, or “stringing,” can save handling time. Each pipe length should be laid on a level surface as near as possible to the trench on the side opposite the excavated trench material; allow some space between pipe to protect pipe ends. The pipe should be out of the way of any equipment in a location that will allow excavation to proceed uninterrupted.

NC-DOT tested, accepted and purchased.

Eliminates Heavy, Expensive Equipment and Saves Labor Time

Labor is always the largest cost component in any buried pipe system.

CPP-HDPE Culverts Drive Down Bid Prices

* Percent savings using HDPE

	12" dia.	24" dia.	36" dia.
South Carolina	N/A	5.82%	N/A
New York	59.59%	38.01%	19.97%
Colorado	24.70%	20.60%	N/A

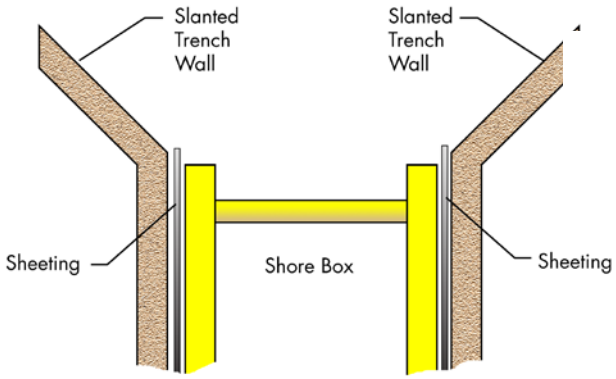
ODOT Pipe Analysis Shows Competition is Good

A 1995 Ohio Department of Transportation study analyzed 22 projects; 50% limited to concrete, 50% allowing concrete and alternate materials. The study found a 22% cost savings when alternate materials were allowed.

* Cost Source: CPPA – PPI

Prevent Cave-Ins

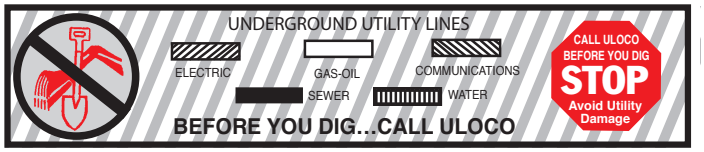
Before beginning installation, one should note that OSHA FILES show that trench CAVE-INS kill more construction workers per year than any other type of construction accident. This includes any type of pipe installation, cable installation or repair.

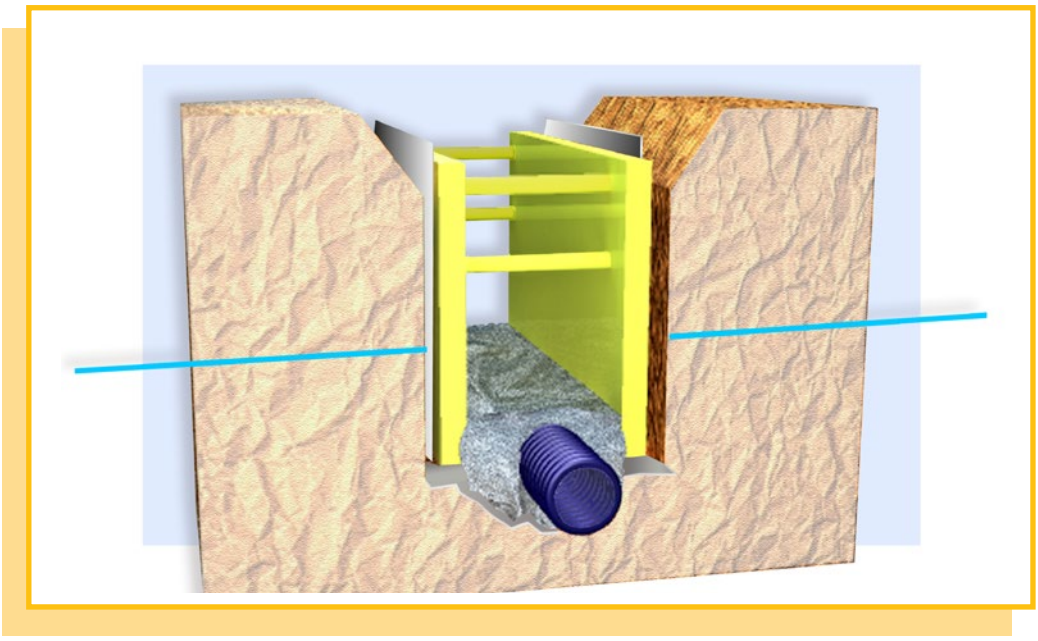


When trenching at unstable soil site points where a Safety-Shore Box cannot offer protection, the trench walls should be slanted on a slope to prevent CAVE-INs. If sheeting is required for trench wall support, and the sheeting is driven into or below the pipe zone, DO NOT remove UNLESS DIRECTED by a Soils Engineer.

Prevent Cave-Ins

In any trench below ground water or below five feet deep, there exists a definite danger of side wall collapse. Factors such as rainfall, water seepage, and the weight plus vibration of nearby heavy equipment can all contribute to CAVE-INS





Trench detail shows non-woven FILTER FABRIC placement around the compacted gravel loadbearing zone. Raising and falling ground water is free to flow, but the FABRIC stops the movement of cohesionless soil, and thus prevents SINKHOLE formation. As with concrete, clay or metal pipe, do not disturb the CPP PIPE or its FABRIC wrapped compacted stone support when moving the Safety-Shore Box to the next position. A pipe work zone “subtrench” below the Safety-Shore Box will prevent disturbance of the FABRIC-GRAVEL support area. The Safety-Shore Box should be a minimum of 3/4 of a pipe’s diameter above the BED FLOOR level. The engineer may require more. All standing water should be removed from the trench area prior to pipe installation. FABRIC sieve opening size must be established by an Engineer. **NOTE: OSHA Regulation demand a site specific safety design for all trenches 20 feet or deeper.**

Backfill Class and Quality

TABLE 1

Pipe Embedment Material						E', psi (kPa) for Degree of Embedment Compaction				
ASTM D 2321*		**ASTM D 2487**		**AASHTO M43 Notation**	**Min. Std. Proctor Density (%)**	**Lift Placement Depth**	**Dumped**	**Slightly** < 85%	**Moderate** 85% - 95%	**High** > 95%
Class	Description	Notation	Description							
1A	Open-graded, clean manufactured aggregates	N/A	Angular crushed stone or rock, crushed gravel, crushed slag; large voids with little or no fines	5 56	Dumped	18" (0.45m)	1000 (6,900)	3000 (20,700)	3000 (20,700)	3000 (20,700)
1B	Dense-graded, clean manufactured, processed agregates	N/A	Angular crushed stone or other Class 1A material and stone/sand mixtures; little or no fines							
11	Clean, Corse-grained soils	GW	Well-graded gravel, gravel/sand mixtures; little or no fines	57 6 67	85%	12" (0.20m)	N/R	1000 (6,900)	2000 (13,800)	3000 (20,700)
		GP	Poorly graded, gravelly sands; little or no fines							
		SW	Well-graded sands, gravelly sands; little or no fines							
		SP	Poorly graded sands, gravelly sands; little or no fines							
111	Coarse-grained soils with fines	GM	Silty gravels, gravel/sand/silt mixtures	Gravel and sand with <10% Fines	90%	9" (0.20m)	N/R	N/R	1000 (6,900)	2000 (13,800)
		GC	Clayey gravels, gravel/sand/clay mixtures							
		SM	Silty sands, sand/ silt mixtures							
		SC	Clayey sands, sand/clay mixtures							
IVA**	Inorganic Fine-grained soils	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity				N/R	N/R	N/R	1000 (6,900)
		CL	Inorganic clays of low to medium plasticity; gravelly, sandy or silty clays; lean clays							
IVB	Inorganic fine-grained soils	MH	Inorganic silts, macaceous or diamaceous fine sandy or silty soils, elastic soils				N/R	N/R	N/R	N/R
		CH	Inorganic clays of high plasticity, fat clays							
V	Inorganic fine-grained soils	OL	Organic silts and organic silty clays of low plasticity				N/R	N/R	N/R	N/R
		OH	Organic clays of medium to high plasticity, organic silts							
		PT	Peat and other high organic soils							

N/R: Use not recommended by ASTM D 2321 for part of the backfill envelope.
* Refer to ASTM D 2321 for more complete soil descriptions.
** Use under the direction of a soils expert.

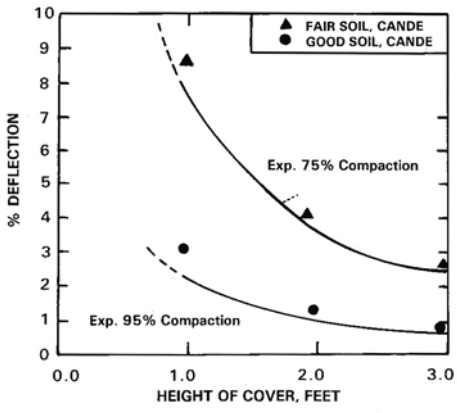
The above table appears in the PLASTIC PIPE INSTITUTE'S Installation & Construction guideline for Corrugated HDPE pipes, ASTM-D-2321 and numerous other plastic pipe installation guides. All soil and soil compaction conditions listed above as N/R (Not Recommended) require a **State Licensed Soil Engineer's** directions for soil reinforcement and remediation. For more, see: **www.plasticpipe.org**

Installation Cover

The following information may be used as a guide by the Engineer, Contractor or Installer to assist in obtaining a successful installation. It contains accurate, reliable information to the best of our knowledge. This information, however, can NOT be guaranteed because the conditions of use and installation execution are beyond our control. This document does not relieve the Engineer, the contractor or the Installer of any responsibility for proper design of an installation or the execution of an installation. This installation guide is based on ASTM-D-2321 plastic pipe installation guide and information available from the Plastic Pipe Institute's Corrugated Pipe Division (PPI-CPPA).

Shallow and deep depths are achieved per **Tables 2** and **3** for **H-25** in LIVE TRAFFIC LOAD situations. The wide range of depths is facilitated by burying the pipe in a GOOD QUALITY SOIL LOAD BEARING ENVELOPE that **eliminates soft voids** or **mushy soils** around the pipe so it will not be prone to shift. When live loads are applied to CPP pipe, its flexible design can utilize the stable compacted side-wall backfill for loadbearing support. A GOOD QUALITY soil backfilled and compacted in **layers** to recommended engineering standards will provide long term, service-strength, Lateral Support against pipe deflection. Soil quality analysis procedures necessary for constructing a load bearing embedment envelope around flexible plastic pipes to provide long term load bearing PIPE-SOIL interaction is principally referenced in ASTM-D-2321, and for soil compaction in ASTM-D-698 or AASHTO-T-99. Additional installation guide lines may also be found at the PPI-CPPA WEB SITE: **www.plasticpipe.org.** Also note Table 1 of the previous page.

Table 2 gives the MINIMUM Soil Cover requirements for 3" to 48" diameter pipe as a function of H-TRUCK LIVE LOADING. The cover depths shown have been tabulated for two soil conditions: (1) FAIR, which represents a CLASS III soil compacted to 85% proctor density; and (2) GOOD, which represents a CLASS III soil compacted to 95%. The accompanying CANDE graph shows pipe deflection decreasing as compaction or depth increase, and the maximum Cover Height Table is shown on Table 3.



Maximum Cover Height Table, Table 2 and CANDE graph source: THE CORRUGATED POLYETHYLENE PIPE ASSOCIATION STUDY titled "Minimum cover Height for HDPE Corrugated Plastic Pipe Under Vehicular Loading" by Katona - 1988

TABLE 2

MINIMUM COVER HEIGHT

Based on Class III Backfill Compacted to 90% Standard Proctor Density and AASHTO H-20 Load

Inside Diameter, ID in (mm)	Minimum Cover, H Ft (m)
3 (75)	1 (0.3)
4 (100)	1 (0.3)
6 (150)	1 (0.3)
8 (200)	1 (0.3)
10 (250)	1 (0.3)
12 (300)	1 (0.3)
15 (375)	1 (0.3)
18 (450)	1 (0.3)
21 (525)	1 (0.3)
24 (600)	1 (0.3)
30 (570)	1 (0.3)
36 (900)	1 (0.3)
42 (1050)	1 (0.3)
48 (1200)	1 (0.3)

The maximum cover limits for corrugated polyethylene pipes in a variety of backfill conditions is shown in Table 3 on page 9. The table shown here assumes the prism load in its calculations. Deeper covers can be obtained using site specific engineered methods beyond the scope of this installation overview. It should be noted that various highway reviews on corrugated polyethylene pipes have shown highway loadings to have negligible effects in deep burials.

These installation guide lines are written for federal - state Highway pipe installation conditions that have improved road bed conditions due to much grading and re-grading work that have improved soil moisture stability. In all agriculture culvert environments such highway preparation, grading work has not been done. Thus, all agricultural pipes should not be installed 6 feet or deeper (from pipe's invert) without the approval of a State Licensed Soils Engineer.

Pipe Cover Sequence

Table 3
Maximum Cover Height Table In Feet

	Class I		Class II				Class III		
Pipe Dia.	Uncompacted	Compacted	85%	90%	95%	100%	85%	90%	95%
4	17(ft)	59(ft)	17(ft)	24(ft)	37(ft)	59(ft)	15(ft)	18(ft)	24(ft)
6	16	57	16	24	36	57	15	17	24
8	14	51	14	21	32	51	13	15	22
10	13	50	13	20	31	50	12	14	21
12	13	49	13	20	31	49	12	14	21
15	13	49	13	20	31	49	12	14	21
18	13	49	13	20	31	49	12	14	21
24	13	51	13	21	32	51	12	14	21
30	13	51	13	21	32	51	12	14	21
36	13	50	13	20	31	50	12	14	21
42	11	47	11	19	29	47	10	13	19
48	11	46	11	18	29	46	10	12	19
54	11	44	11	18	28	44	10	12	18
60	11	45	11	18	28	45	10	12	19

Two or more parallel pipes in the same trench also require minimum spacing, properly compacted backfill. Table 5 below shows the minimum needed. Engineers may require more.

Table 5
Minimum Spacing of Parallel Pipes In A Single Trench

Normal Diameter (D) in. (mm)	Minimum Spacing in. (mm)
≤ 24 (600)	12 (300)
> 24 (600)	D/2

Table 6 containes live load data for AASHTO H-25 or HS-25 and Cooper E-80 (P_L, L_W) railroad loadings. See Chapter 5 of the PPI-CPPA Design Manual at **www.plasticpipe.org** for more information.

For airport runways, it should be noted that aircraft loadings vary widely, and the FAA Pavement Design Manual should be referenced at the FAA web site.

Notes:
1) Includes impact where required.
2) N/R indicates that the cover height is not recommended.
3) N/A indicates that the information is not applicable.
4) Information has been modified from Buried Pipe design, Moser, McGraw-Hill, 1990, p. 34.

Another point for contractors to keep in mind before beginning any excavation for CPP pipe installation is Trench Width. Overly wide trenches can be more expensive to compact, but a minimum of width is needed for joining, and for compaction. AASHTO Section 30 highway codes call for a width of not less than 1.5 times the pipes OUTSIDE diameter, plus 12 inches. ASTM-D-2321 installation specifications requires a trench width of 16 inches plus the pipes OUTSIDE diameter or 1.25 times the pipes OUTSIDE diameter plus 12 inches.

Table 4
Maximum Trench Width'

Inside Diameter In. (mm)	Typical Outside Diameter In. (mm)	AASHTO Sec 30 Min. Trench Width In. (mm)	ASTM D 2321 Min. Trench Width In. (mm)
4 (100)	5 (120)	19 (480)	21 (530)
6 (150)	7 (177)	22 (570)	23 (580)
8 (200)	9 (233)	26 (650)	25 (640)
10 (250)	11 (287)	29 (740)	27 (690)
12 (300)	14 (356)	33 (840)	30 (760)
15 (375)	18 (450)	39 (980)	34 (870)
18 (450)	21 (536)	44 (1110)	38 (970)
21 (525)	24 (622)	49 (1240)	43 (1080)
24 (600)	27 (699)	53 (1350)	46 (1180)
30 (750)	34 (866)	63 (1600)	55 (1390)
36 (900)	41 (1041)	73 (1870)	63 (1610)
42 (1050)	48 (1219)	84 (2130)	72 (1830)
48 (1200)	54 (1372)	93 (2360)	80 (2020)
54 (1350)	61 (1577)	105 (2670)	90 (2276)
60 (1500)	67 (1707)	113 (2870)	96 (2440)
72(1800)	80 (2032)	132 (3350)	112 (2840)

Table 6
Live Load Data for AASHTO H-25 or HS-25 and Cooper E-89 (P_L, L_W)

Cover, ft. (m)	AASHTO H-25 or HS-25[1]		Cooper E-80[1]	Cover, ft. (m)	AASHTO H-25 or HS-25[1]		Cooper E-80[1]
	Live Load Transferred to Pipe, P_L, psi (N/mm^2)	Live Load Distribution Width, L_W in (mm)	Live Load Transferred to Pipe, P_L, psi (N/mm^2)		Live Load Transferred to Pipe, P_L, psi (N/mm^2)	Live Load Distribution Width, L_W in (mm)	Live Load Transferred to Pipe, P_L, psi (N/mm^2)
1 (0.3)	15.63 (0.108)	31 (787)	N/R	14 (4.3)	negligible	N/A	4.17 (0.0288)
2 (0.6)	6.95 (0.048)	52 (1321)	26.39 (0.1824)	16 (4.9)	negligible	N/A	3.47 (0.0240)
3 (0.9)	5.21 (0.036)	73 (1854)	23.61 (0.1632)	18 (5.5)	negligible	N/A	2.78 (0.0192)
4 (1.2)	3.48 (0.024)	94 (2388)	18.40 (0.1272)	20 (6.1)	negligible	N/A	2.08 (0.0144)
5 (1.5)	2.18 (0.015)	115 (2921)	16.67 (0.1152	22 (6.7)	negligible	N/A	1.91 (0.0132)
6 (1.8)	1.74 (0.012)	136 (3454)	15.63 (0.1080)	24 (7.3)	negligible	N/A	1.74 (0.0120)
7 (2.1)	1.53 (0.011)	157 (3988)	12.15 (0.0840)	26 (7.9)	negligible	N/A	1.39 (0.0096)
8 (2.4)	0.86 (0.006)	178 (4521)	11.11 (0.0768)	28 (8.5)	negligible	N/A	1.04 (0.0072)
10 (3.0)	negligible	N/A	7.64 (0.0528)	30 (9.1)	negligible	N/A	0.69 (0.0048)
12 (3.7)	negligible	N/A	5.56 (0.0384	35 (10.7)	negligible	N/A	negligible

Installation
Trenching & Bedding Sequence

TRENCHING INSTALLATION SEQUENCE

An undisturbed, firm trench wall is the unmovable base against which the compacted SOIL ENVELOPE material that immediately surrounds the pipe rests. The undisturbed, firm trench wall and the COMPACTED ENVELOPE together actually carry the load. In stable soils excavate as narrow a trench as needed to install, and compact around the pipe. Narrow trenches will save time and compaction costs. If trenching in unstable soils, a Licensed Soils Engineer may require additional excavation in order to stabilize or bridge over soft soil pockets. Also when trenching in unstable soil, the trench walls should be slanted on a slope both for safety, and to assist the installer in preventing the pipe from being misaligned by unstable soil cave-ins. As noted in Table 1, Class IV, V and other N/R soils **require the evaluation of a Licensed Geotechnical Engineer.** Gravel packed envelopes enclosed in a filter wrap are generally required per ASTM-D-2321 to provide pipe support, and control water migration of cohesionless material. ASTM-D-2321 also notes other soil stabilization option strategies in addition to gravel packed filter wrapped pipe support cells for improving soil structure interaction stability.

BEDDING INSTALLATION SEQUENCE

Just as firm trench walls provide solid side support and prevent side shifting in plastic pipe systems, so too must the bed upon which the pipe lays **be free of soft spots** to provide longitudinal support along the length of the pipe. If the pipe is not uniformly supported along its length by a firm, unmovable floor or bedding, then differential settlements can cause pipe sagging to occur. Sagging can create water flow backups. To provide good longitudinal bed support, construct the BEDDING ZONE per the appropriate SOIL TYPE as described in Tables 1 & 7. The BEDDING ZONE as shown in the PIPE COVER SEQUENCE DIAGRAM is the top of the trench grade that the pipe lays on. This BED should be SMOOTH and FREE of LARGE ROCKS or other protrusions which may cause point loading on the pipe. Do not allow rocks of over 1½" to come in contact with the pipe. Class I soils are smooth graded. Class II and III soils are smooth graded, and then compacted to desired grade. Class IV and V soils must be over excavated by at least 6 inches, and filled with compacted material to grade per Table 7. A geotechnical evaluation **may require** additional over excavation and filter wrapped fill if a future high water table level is expected in the pipe support zone.

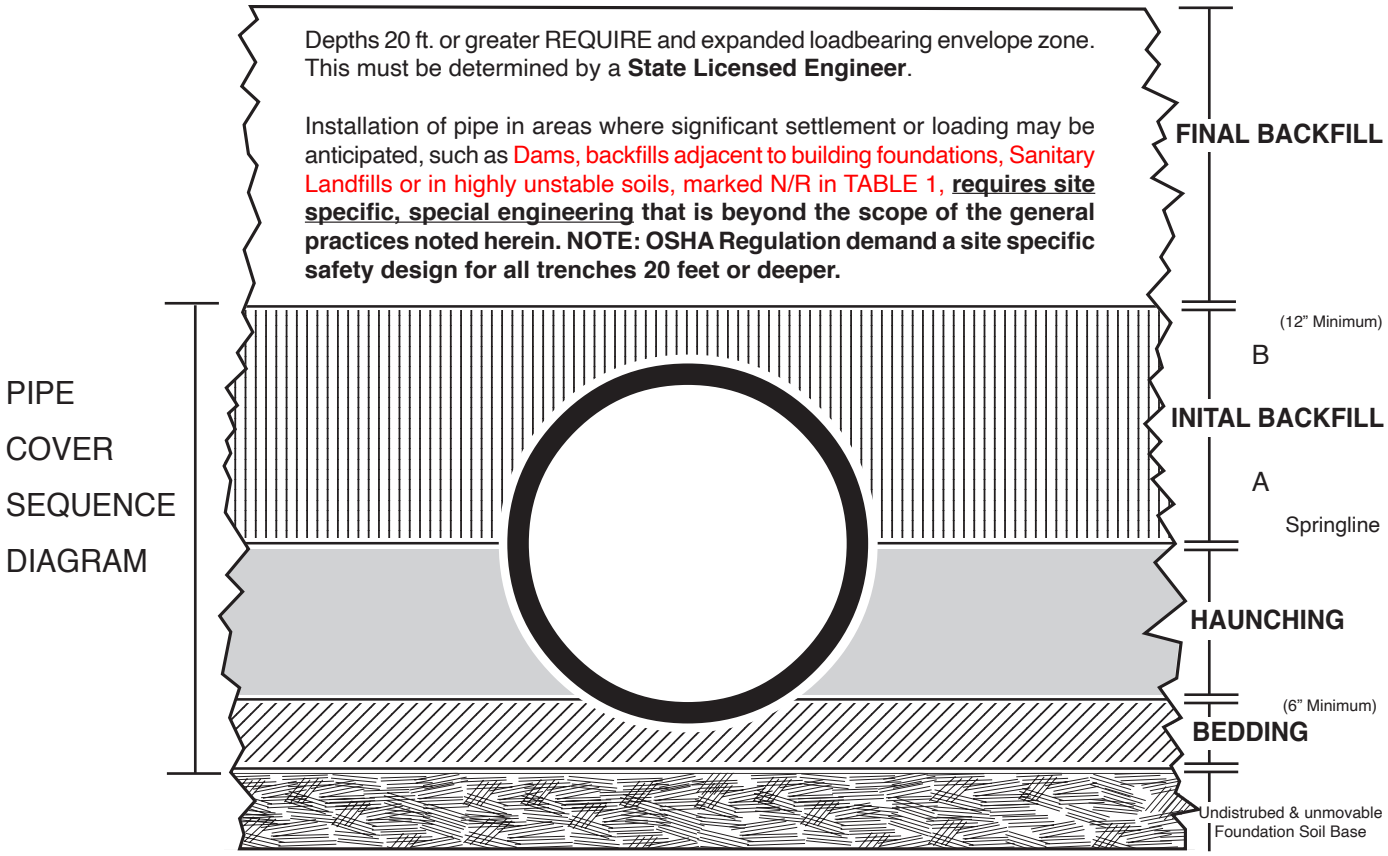
TABLE 7

TRENCH & BEDDING CONSTRUCTION METHODS PER SOIL CLASSIFICATION			
Class I	Class II & III	Class IV	Class V
Excavate to grade and begin installation. Make sure no rock over 1½" in size makes contact with the pipe	Excavate to a point above grade & compact loose material to the desired BEDDING COMPACTION DENSITY PERCENTAGE. *	Since this soil is not readily compactable, excavate at least 6" below grade. Then fill & compact a BEDDING LAYER to grade. ** A licensed geotechnical evaluation is **required.**	Similar to Class IV. However, may need to excavate over 6" to below existing ground water or a future predicted grade water level. ** A licensed geotechnical evaluation is **required.**

* NOTE: If using a Class I Stone envelope material in a trench of Class II soil, use a filter wrap. If using a Class II sand envelope material in a trench of Class III soil, use a filter wrap.

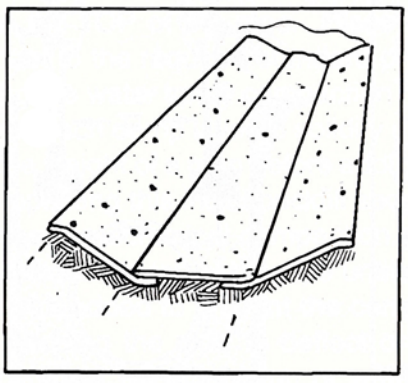
** NOTE: Must use a filter wrap or employ other soil stabilization stratagies in Class IV, V and N/R soils as noted in ASTM-D-2321 per the determination of a **State Licensed Geotechnical Engineer**.

Pipe Installation Sequence



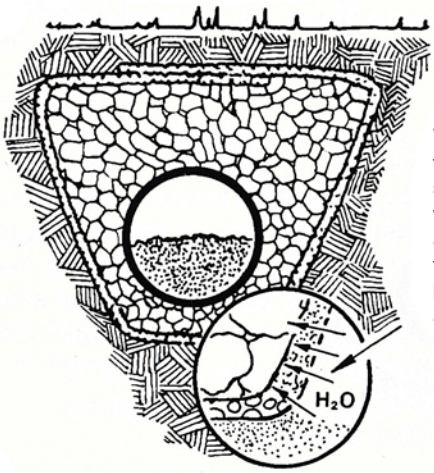
If a Class I stone material is used for BEDDING material in a Class II or lower soil type classification trench, a FILTER WRAP should be placed down prior to adding the Bedding material. A FILTER WRAP, as shown in FILTER DIAGRAMS A & B, will allow water to pass, but prevent the trench BED or WALL soils from migrating with rain waters into the rock envelope. This will stabilize both the ENVELOPE ZONE and the SUPPORT SOILS that surround it. If a Class II soil is used for BEDDING material in a Class III or lower soil type trench classification a FILTER WRAP should be used also. In addition to a filter wrap, an ANTI-SEEP COLLAR may be required along the pipe run to prevent the water flow migration of soil fines along the length of the pipe.

FILTER DIAGRAM "A"



Lay down filter fabric prior to placing load-bearing envelope material and foundation bedding materials.

FILTER DIAGRAM "B"



Water can pass easily through the gravel-pack or a sand envelope's exterior filter wrap, while waterborne fines are filtered out. This construction technique will provide both a stable envelope soil and a stable trench soil

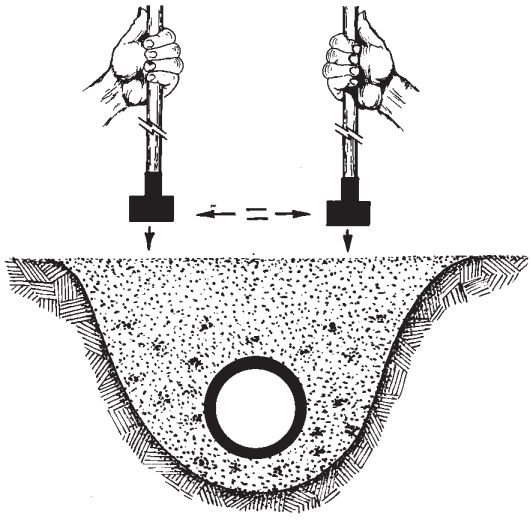
Haunching Backfill Sequence

The Haunching Zone as shown in the pipe cover sequence diagram is between the BEDDING ZONE and the Lower Half of the pipe below the SPRINGLINE. If a Class I type of rock or stone was used in the BEDDING SEQUENCE, it is mandatory that it be used in the HAUNCHING BACKFILL SEQUENCE up to the SPRINGLINE. This continued use of Class I material will prevent the loss of HAUNCHING'S side support that would occur if a Class II or Class III soil were used since these latter soil types would migrate into the voids of a Class I stone type bedding base. If a Class II sand was used in the BEDDING SEQUENCE of a Class III soil, then Class II should be used up to the SPRINGLINE for haunching backfill material also as different soils in the haunching area may react differently to moisture changes. The continued use of the same material from BEDDING to SPRINGLINE in conjunction with the use of a filter fabric will stabilize the environment in which the pipe is buried. **If the pipe is being installed below existing or future predicted ground water levels, a Class I Gravel must be used to the TOP of the pipe encased in a filter wrap.** CPP Mastic Wrap leak resistant couplers as described in the coupler section of this booklet on pages 22 and 23 must be used at expected high water sites to prevent the water migration of cohesionless soils into pipe joints that could cause future sink holes.

If a Class I stone is used as HAUNCHING ENVELOPE material, simple dumping and leveling can achieve the required compaction level. If a Class II sand is used, employing the water spray compaction method to obtain the required compaction density is effective. Lay out the sand in 6 INCH LIFTS and spray each lift, but avoid saturation and puddling. As a rule of thumb, the dryer the soil, the stronger and more stable it is. However, a slightly damp material will generally result in maximum compaction with minimum effort. Do not use this method in freezing weather though, as ice pocket voids may be created.

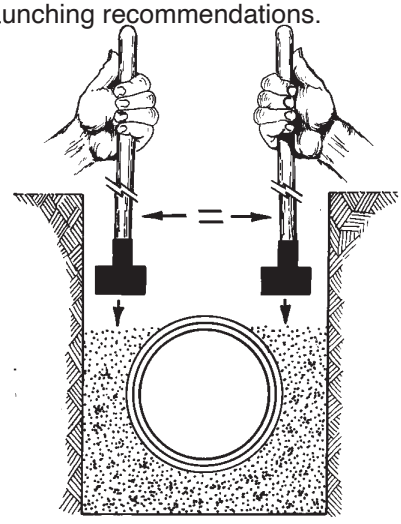
While Class III soils are allowed as a compaction envelope material, more care and compaction time must be taken to achieve the required proctor density compaction level. Class III soils should be laid out in 3 INCH LIFTS. Even though water-spray compaction is allowed in Class III soils, HAND-HELD tamping is generally recommended because this can be faster than waiting for the sun and air to dry out each lift. As a result of the extra time spent on compaction, Class III soils can be more expensive to use than imported Class I or Class II soils even if the Class III soil is provided free. Many knowledgable pipe contractors economize both labor cost and imported soil envelope cost at CLASS III sites by importing a class II sand, and mixing this 50/50 with the site native class III soil. The native class III soil generally provides enough dampness when mixed with the class II sand to provide a quick maximum compaction job with little effort. The final compacted soil's moisture content should be 9.5% or less. If a higher post-construction, soil moisture content is expected, a filter wrapped soil support cell should be considered.

To make sure that no movement occurs in the pipe during HAUNCHING, SPECIAL CARE should be taken to adequately fill and shape the HAUNCHING material to the Bottom Half CURVATURE of the pipe equally all on each side. Failure to adequately fill and compact under the SPRINGLINE bottom half CURVATURE can create loose voids that will later allow movement during a live load. To avoid this, place the HAUNCHING fill material in 3 inch or 6 inch layers, and compact prior to laying down another lift. If using the water spray compaction method, do not puddle, and allow each layer to solidify. Be sure to compact each layer out to the undisturbed trench side wall for assured side wall lateral support. Also see page 16 for 30" and larger size pipe bottom half haunching recommendations.



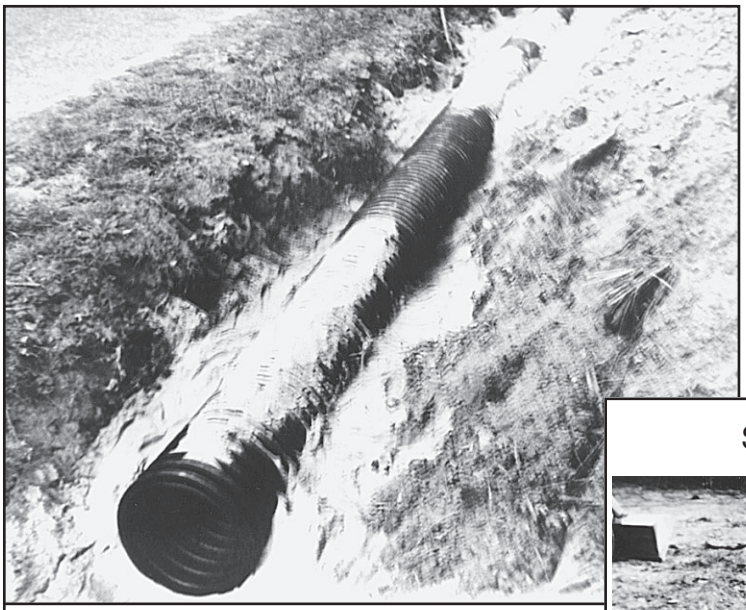
Existing Open Ditch Example

Compact equally on each side of the pipe in layers to eliminate soft spots that can cause pipe shifting during installation. Compact fully to the firm undisturbed trench walls to assure firm soil support around the pipe.

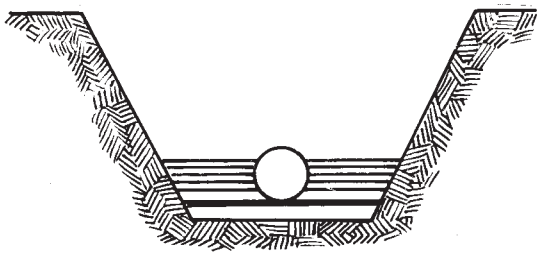


Constructed Ditch Example

Initial Backfill Sequence



6” Bedding Zone Required Under Pipe



Compact bedding and the envelope zone in layers to eliminate soft spots that can cause shifting

Stiff Soil under, around and on top

Water spray compaction is effective, and labor cost efficient in Class II sand soil types. Class III soils however can be compacted over a wide range of densities due to moisture variability potential. To achieve good compaction in Class III soils, the soil’s moisture content should be 9.5% or less. In these soils, compaction installation economies can be achieved by mixing imported sand 50/50 with the native Class III clays.

The Initial Backfill Sequence covers the space between the pipe’s SPRINGLINE to a point 6” above the top of the pipe; it takes place in two steps: (1) Step one is from the SPRINGLINE to the TOP of the pipe: (2) Step two is from the top of the pipe to a point 6” above the TOP of the pipe. Place each lift, and compact to the required standard proctor density. If using the water spray compaction method, allow time for each damp layer to solidify until it will support the weight of a man before adding the next lift. In compacting this Initial Backfill Sequence, do not use heavy mechanical compaction equipment directly above the top of the pipe until ample backfill has been added to prevent the compaction event from causing the pipe to deflect or bend out-of-round. Light hand tamping or water spray compaction, which will solidify soil and eliminate voids without deflecting the pipe, is recommended here for Class II or Class III soils; Class I soils will compact upon dumping with little extra effort other than smooth grading. In this compaction phase, compact the side wall portion of the backfill fully to the side wall, as side wall lateral support is what is essential for the load carrying. Again, only use light hand tamping or water spray to compact away loose material over the top. Provide at least 48 inches of cover DIRECTLY OVER THE TOP before the utilization of a hydrohammer for compaction. If using a front-end loader to deposit Class I or Class II material in the trench, FEATHERDUMP in 6” layers so the required compaction can be achieved quickly. If using a Class III material, dump in 3” layers. Once step two has been completed 6” above the top of the pipe in this phase, close off the filter fabric wrap by overlapping if one has been required.

Final Backfill Sequence

When the Initial Backfill Sequence has been installed to a point 6” above the top of the pipe, and the filter fabric has been overlapped to the closed position, only an additional 6” of COMPACTED material is needed in this, the Final Backfill Sequence, if LIVE LOAD TRAFFIC BEARING is expected. Otherwise, COMPACTED Class I, II or III material is not needed in the Final Backfill zone **except as specified by a licensed engineer** in a Class IV, V or N/R soil or a high water table situation. Also at depths of 20 feet or deeper, additional compacted material may be needed in the Final Backfill zone depending on the soil type profile at each site as determined by an engineer.

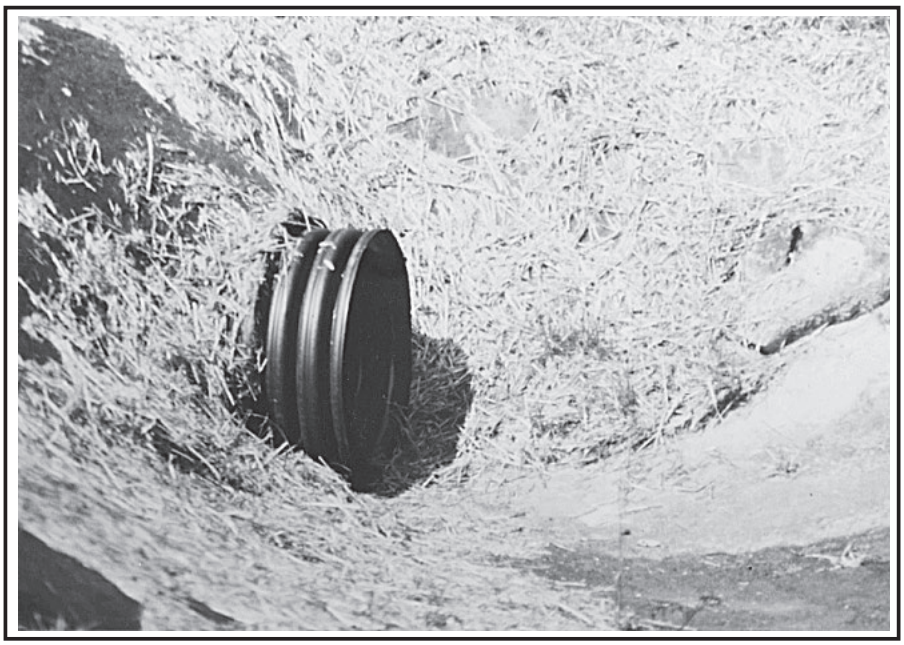
PAVING

As a footnote to TRENCH and COVER installation requirements, the paving material of concrete and asphalt should be noted. In most construction cycles, pipe installation comes at the beginning of a job, and paving at the END. The minimum cover height shown in the Table 2 page 8 is based on the UNPAVED COVER height needed to substain H-20 TRUCK LIVE LOADINGS. This includes H-20 CONSTRUCTION LOAD TRAFFIC, but not the heavier H-25/H-30 construction loads like brick, ready-mix, loaded motor graders, etc. Both asphalt and concrete greatly reduce the deflection loading on shallow buried plastic pipe, and 6” of pavement material can be substituted for the last 6” of the backfill phase. Local highway department subdivision rules however may very. Thus local road officials should be consulted prior to installation to identify site specific construction needs.

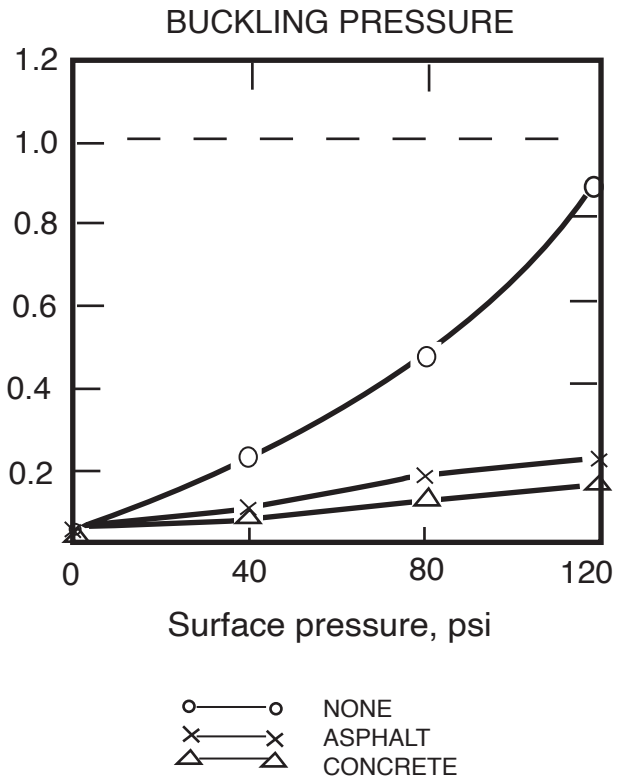
In cases where the pre-paving depth is less than THREE FEET, and the paving cannot be rescheduled towards the beginning of the construction cycle, MOUNDING should be employed to protect the pipe during construction in a way similarly recommended for concrete, clay or metal pipes. The mounding of three feet of compacted fill over the pipes should be used at CONSTRUCTION CROSS-OVER SITES. Non cross over areas should be red flagged to prevent accidental crossings. The MOUNDING RAMP should extend to each side of the pipe for a distance of 1.5 times the diameter plus twelve inches. During regrading of the Mound for paving preparation, care should be taken not to deflect the pipe out-of-round. Care should also be taken by the paving equipment operator to avoid pipe damage or setting deflection in the pipe. If installed correctly, concrete and asphalt paving allow for the use of CPP pipe systems at any depth.

Because paving does allow for traffic bearing over CPP’s durable, light weight pipe systems at shallow or deep depths, CPP pipes fill a multitude of cost saving needs on large paving jobs like shopping mall parking lots and airport runway storm water control systems. Both asphalt and concrete can be easily formed to make catch basins as well as attractive, useful headwalls. Preformed or cast-in-place headwalls and flared end sections will allow for the mowing of roadside vegetation and other weed control programs, like Fall burnings, without damage to plastic pipes as is also done with bituminous coated metal or concrete pipes.

Paving



Asphalt Paving of Swale Area and Headwall around pipe cuts down erosion, offers exposure protection to HDPE pipe and beautifies landscape of areas.



Source: Corrugated Polyethylene Pipe Association Study Titled “Minimum cover Height for HDPE Corrugated Plastic Pipe Under Vehicular Loading” by Katona-1988

Other Installation Tips

This installation guide is based on plastic pipe installation practices described in ASTM-D-2321 along with the PPI-CPPA installation guide that can be accessed at the PPI Web site: **www.plasticpipe.org**. Both installation practices are utilized by Federal and State Highway construction engineers.

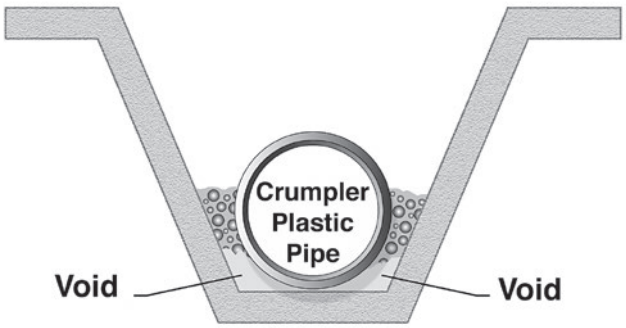
As with the above noted plastic pipe installation guide lines, this guide also does not purport to address all the variables that can occur at a specific site or for specific uses. Sites with non-uniform soils will require soil specific structure, reinforcement modifications that are beyond the scope of any general guideline. Such soil site specific modifications **will require** the services of a **licensed engineer**. This is especially true for CLASS IV and V soil types, and other types classified as N/R (Not Recommended) on the Table 1 Pipe Embedment Material Chart of page 7 herein.

In addition to this general warning about unstable soils, the need to employ an engineer may be even required at some of the following sites because they can produce localized pipe point loads that require special soil reinforcement practices:

- All Depths 20 Feet or more
- Agricultural applications deeper than 6 feet from the pipe's bottom due to soil moisture variations
- Backfills adjacent to or in between buildings and their foundations
- Sanitary Landfills
- Raising and Falling Water Table sites
- Dams
- Retaining Wall penetrations
- Crossing Existing pipes
- New Pipe laid parallel to existing pipes
- Catch Basin/Manhole Connections
- Vertical Risers
- Standing Water Trenches
- Continuous water flow in CPP non-pressure pipes require CPP Mastic Wrap couplers and the Entry point requires a Headwall with Wings to ease the water into the pipe walls. Exits should also have Flared Ends or Rip-Rap to help control erosion.

At these points an engineer **must** determine the practice required to establish a firm soil pipe support that addresses time dependent site specific soil moisture change potential that could effect post construction pipe deflection or over deflection. **Flowable Fill Motars** up to the Haunch Line, as a minimum, is sometimes required at Class IV and V sites, and N/R sites.

This guide and the above installation precautions are, in short, about eliminating SOFT SPOTS around flexible plastic pipes that can cause pipe systems to over deflect. The same precautions are observed for rigid pipe materials to prevent misalignment soil related shifting. The elimination of SOFT SPOTS under 24" diameter and smaller pipes has been found to be easier than under 30" and larger pipes because of the flatter curvature of 30" and larger size pipes. The flatter curve of 30" and larger pipes makes it more difficult for installers to achieve the required 95% Proctor Density Compaction level due to the flow of backfill into the large restricted area under the pipes bottom half Haunch line. For this reason, CPP, Inc. recommends that a well graded, select material or Class II material be used for the compaction soil up to the Haunch Line on 30" and larger size pipes in Class III soils. For Class IV and other N/R soil types per Table 1 on page 7, an engineer may still require a Class I gravel with a Filter wrap.



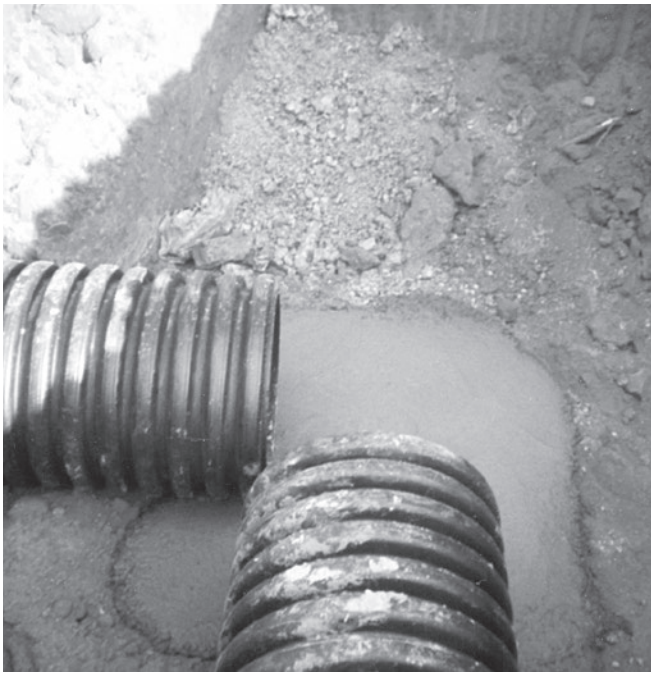
Class III mini clods in 3" backfill lifts often do not seat and compact under the lowest portions of 30" and larger pipes due to their long curvatures. Thus a well graded, select material or Class II material, compacted to the Haunch Line is recommended for 30" and larger sizes in Class III soils. For Class IV and other N/R types per Table 1, an engineer may still recommend a Class I gravel with a Filter wrap.

Do NOT assume that COMPACTION can stop at the Haunch Line or the pipe's crown if no traffic is expected in the Post Construction period. The backfill must be compacted for at least 12" above the pipes Crown for long lasting soil support of flexible pipes.

Contractors should not excavate more trench length than can receive pipe in a day. Should multi-day excavation occur, all native soils to be used as backfill should be tarp covered to prevent extra soil moisture related softness from occuring in the fill overnight or during a rain event.

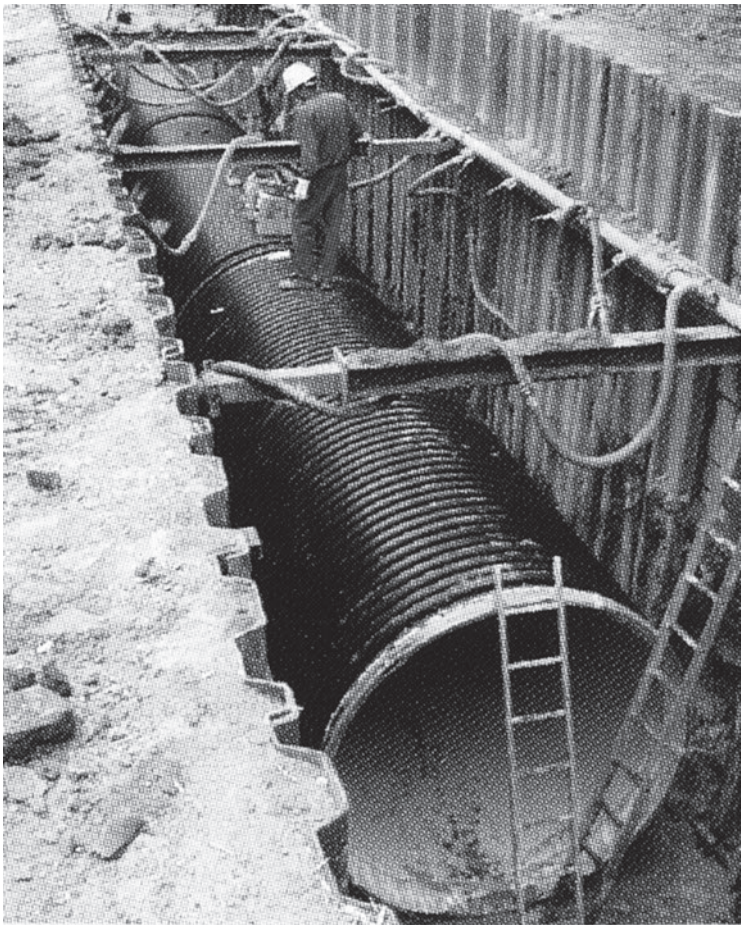
Soil Remediation / Stabilization

Sites such as Detention ponds always have wet, mushy soils that must be improved for loadbearing with or without traffic loading in order to eliminate differential settlement that occurs with changing water levels.



A concrete pad is poured to provide firm bedding support around a CPP pipe fitting. Such extra installation measures will reduce the possibility of future construction related damage to any pipe system, no matter its raw material base.

At sites where water tables vary with annual rain fall peaks, IN PLACE SHORING in combination with filter wrapped gravel-packs can be required to assure long term pipe-soil support per ASTM-D-2321.



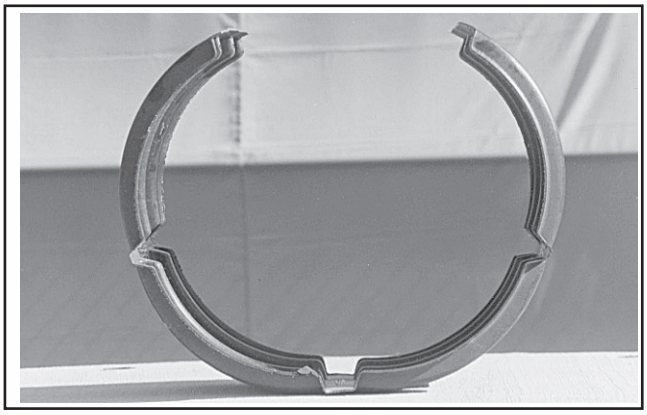
Such measures are needed at these sites whether traffic is expected or not. In addition, sites where soil types vary greatly, either naturally or from previous fill construction practices, are likely to provide the conditions that require extra soil stabilization efforts.

Coupling Selection

CPP offers different types of coupling systems to fit a variety of site engineering requirements

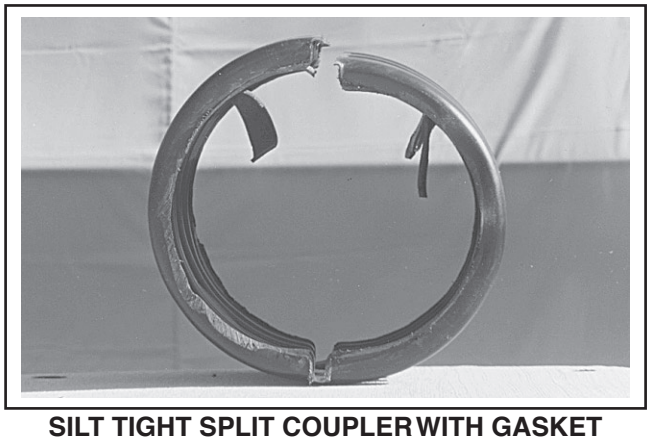
Plain-End Pipe Couplers

1. **SOIL TIGHT SPLIT COUPLER** - this is a Clam Shell type coupler used in Non-Water Tight applications. They are used on perforated or solid style CPP pipes at sites where the native soil is stiff and cohesive enough to reduce the possibility of a loose soil infiltration into the pipe that could create a flow restriction.



SOIL TIGHT SPLIT COUPLER

2. **SILT TIGHT SPLIT COUPLER** - these are Clam Shell type couplers to which a gasket material has been added for the purpose of restricting Silt infiltration into the pipe at a coupling joint. This non-water tight gasket material meets ASTM-D-1056, Grade 2A2 or ASTM-F-477. The installer should take care to remove all dirt and foreign matter from the pipe ends and gasket material to insure a secure fit.



SILT TIGHT SPLIT COUPLER WITH GASKET

Bell & Spigot Couplers with "O" Ring Gaskets

3. CPP offers several types of GRAVITY FLOW couplers to impede or prevent the infiltration or exfiltration of liquids in NON-PRESSURE applications: **a.** Bell & Spigot **b.** CPP Sheer Gasket **c.** CPP Mastic Wrap

CPP 12" TO 24" Meet 10.8 psi Lab Test With One ASTM-F-477 "O" Ring

A Toggle Bold On The Stainless Steel Band Can Be Tightened After Assembly of 30" to 48"

CPP 30" to 48" Meet 10.8 psi Lab Test With One ASTM-F-477 "O" Ring and a Stainless Steel Strap

a. BELL & SPIGOT WITH "O" RING GASKETS – these couplers come with a water seal restricting gasket manufactured per ASTM-F-477. These couplers meet the 10.8 psi Pre-Installation, Gravity Flow, Pipe Joint Laboratory Test ASTM-D-3212. State Highway Departments and others knowledgeable in pipe installing often note in writing pipe job installation specifications that Lab Tests of pipe joints are not intended to indicate any Field Performance of a pipe joint, but only a joint's performance under ideal Lab conditions. For Installed Joint Testing, some inspecting authorities may call for ASTM-F-2487 (06), which is a specification written specifically for Polyethylene Corrugated Pipe Installed Joint performance.

CPP 12"-to-24" meet the ASTM-D-3212 Lab Test 10.8 psi requirement with one ASTM-F-477 "O" Ring. CPP 30"-to-48" with one "O" Ring, meet the ASTM-D-3212 10.8 psi level as modified with a Factory Applied Stainless Steel Band around the Bell. The Stainless Steel Band may be Toggle Bolt tightened one or two turns after the pipe is assembled. This Toggle Bolt Field tightening sequence can assist in a Bell's return to its pre-assembled normal circumference after being strained/stretched by an assembly that utilizes large equipment, which is prone to applying unknown insertion forces.

As with concrete, metal or clay pipes, the installer must take precautions at all coupling sites that have historically been a **SINKHOLE** formation problem of failure, no matter a pipe's raw material base. Like any coupling junction, Man-Hole Tie-In, existing pipe Cross-over points, etc. extra installing care must be taken to insure that the uniform 95% Proctor Density compaction soil support is available per ASTM Installation specifications D-2321 and the PPI-CPPA Installation guide. The correct soil compaction level prevents deflection stresses on CPP Pipes from exceeding 5%, and thus protects from an over-deflection on the coupler's "O" Ring Seals as well.

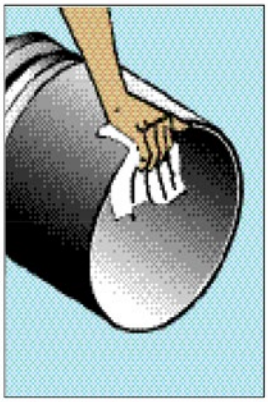
The bedding of the pipe and joints must be without Reverse Grades that could bend, pinch or misalign a joint assemblage that would prevent a joint seal. If CPP pipes are installed in soils that are expected to experience any movement from a future high water table or soil-moisture ratio change, a GRAVEL PACK LOADBEARING ENVELOPE ENCASED INSIDE a FILTER WRAP, **must** be used. Soils not reinforced properly to withstand soil-moisture changes, can result in a MUSHY soil that will increase a pipe's deflection to the point of jeopardizing a joint leak resistant gasket seal. This is particularly true in non-cohesive silts, Class IV, Class V and N/R soils. It should be noted that the flexibility of CPP pipes is an attribute that accommodates minor post installation soil settling and shifting, and thus prevents many opportunities of catastrophic differential, sheer loading related joint misalignments that are often experienced by the more rigid pipe system materials. The 20-foot sections of CPP pipes also reduce joint failure opportunities because there are fewer joints. However, in Class IV, V or other Fluctuating Water-Table prone soils, soils reinforcement practices (as noted in ASTM-D-2321) must be selected to assure performance as would be required for the installation of rigid pipe products. Under these site conditions, a CPP MASTIC WRAP COUPLER should be specified by the Engineer to avoid leakage that could lead to possible Sinkhole formations that may develop years after an installation.

CPP **O Ring** gaskets are **SELF LUBED** gaskets and do not need any additional pipe lube applied to the male spigot or female bell. Additional site applied lube can cause the coupling joints to slide apart during backfill. Thus, do not apply any. First remove the protective plastic wrap from the **O Ring** gasket on the male spigot end. Both the males spigot and female bell ends should be cleaned to remove any dirt or loose trench soil from the coupling joint work area. If overnight rain has caused any loose soil to become caked mud in the bell, sufficient water may be applied to remove this, but the area should be dried before beginning the coupling process. The female bell end should cover two male spigot corrugations when fully seated.

Bell & Spigot Couplers with "O" Ring Gaskets

Step 1

Remove the protective cover from the "O" Ring and make sure the "O" ring is firmly seated.

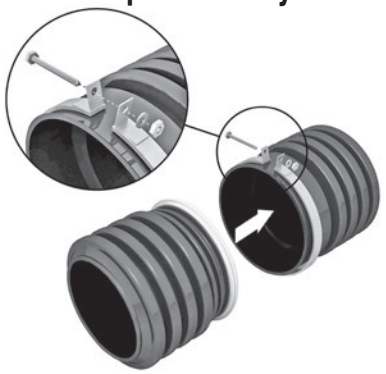


Step 2

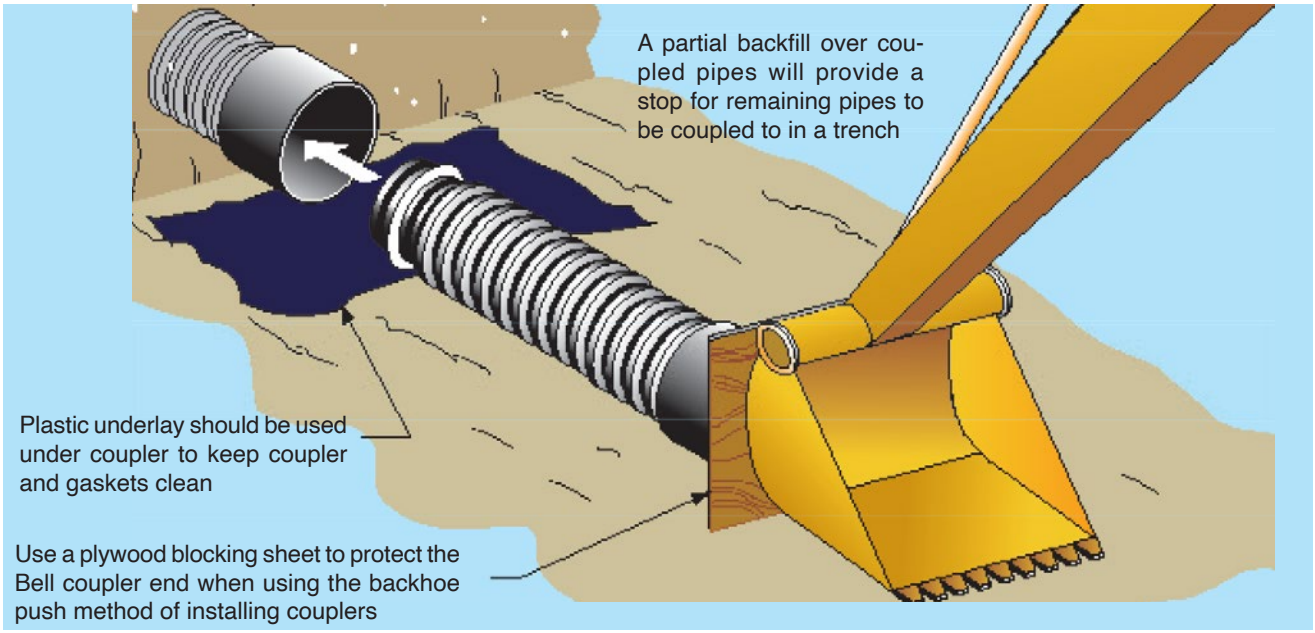
Clean pipe, the "O" ring and the bell coupler of all mud, grit, etc..

CPP 30"-to- 48" 10.8 psi Joint Systems

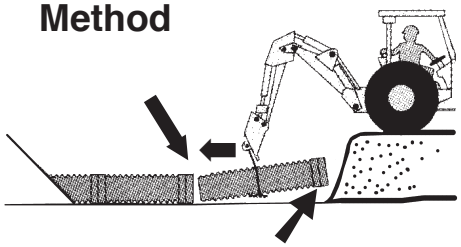
When full seated, two corrugations should be covered.



At sites where ASTM-D-3212 LAB TESTED Joints are required for 30" -to- 48" In-Line Molded Couplers, CPP offers Factory Applied Stainless Steel Straps that can be TOGGLE BOLT Tightened by One or Two Turns for uniform Gasket Engagement between the BELL & SPIGOT Surfaces **AFTER** Field Assembly.

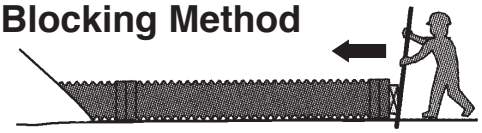


Backhoe Sling Method



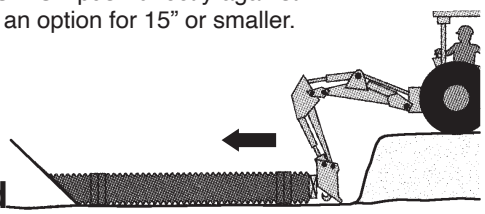
NOTE: Wrap nylon sling around center. Guide pipe squarely into bell to avoid misalignment.

Bar/Sheet Blocking Method



NOTE: This method requires use of installation blocking sheet. DO NOT push directly against pipe. This method an option for 15" or smaller.

Backhoe Push Method



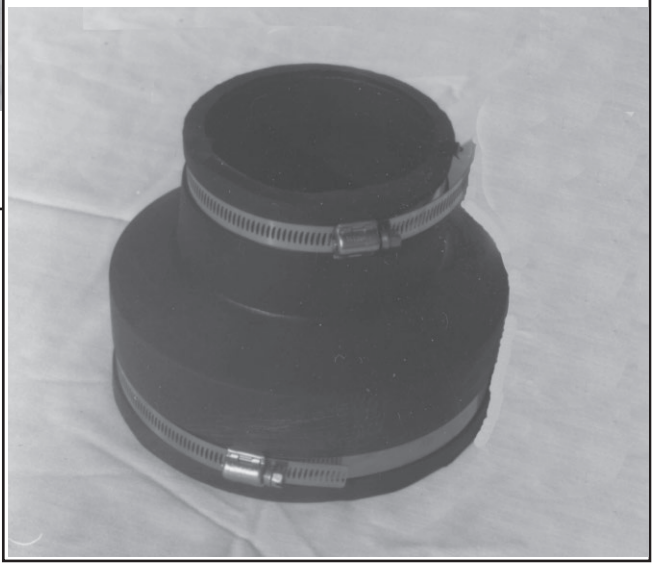
NOTE: This method requires use of installation blocking sheet. DO NOT push backhoe directly against pipe.

Shear Gasket Couplers with Stainless Steel Compression Bands

b. **CPP SHEAR GASKET GRAVITY FLOW SEAL COUPLERS** - These pliable couplers with stainless steel Clamp-Grip Compression bands have been used for years connecting clay, concrete, steel and plastic pipes in all types of environments. They are impervious to normal sewer gases, chemicals, fungus growth and all other associated in-ground hazards. Although, not technically correct, many CPP customers refer to this coupler as the radiator-hose style coupler because of the compression grip that the stainless steel bands provide. As with any coupler, before applying, insure that no foreign matter jeopardizes contact between the two surfaces. These couplers impede leakage on 8" and smaller pipes. Minor leaks may be experienced on full flow surges. For larger size pipes the CPP MASTIC WRAP coupler is recommended. See item "C" that follows.

SHEAR GASKET GRAVITY FLOW WATER TIGHT COUPLERS

REDUCER-ADAPTER SHEAR GASKET COUPLERS



Loosen Stainless Steel Compression Clamps, and clean surfaces prior to insertion.

Slip the coupler over the ends of pipes to be joined, and tighten clamps.

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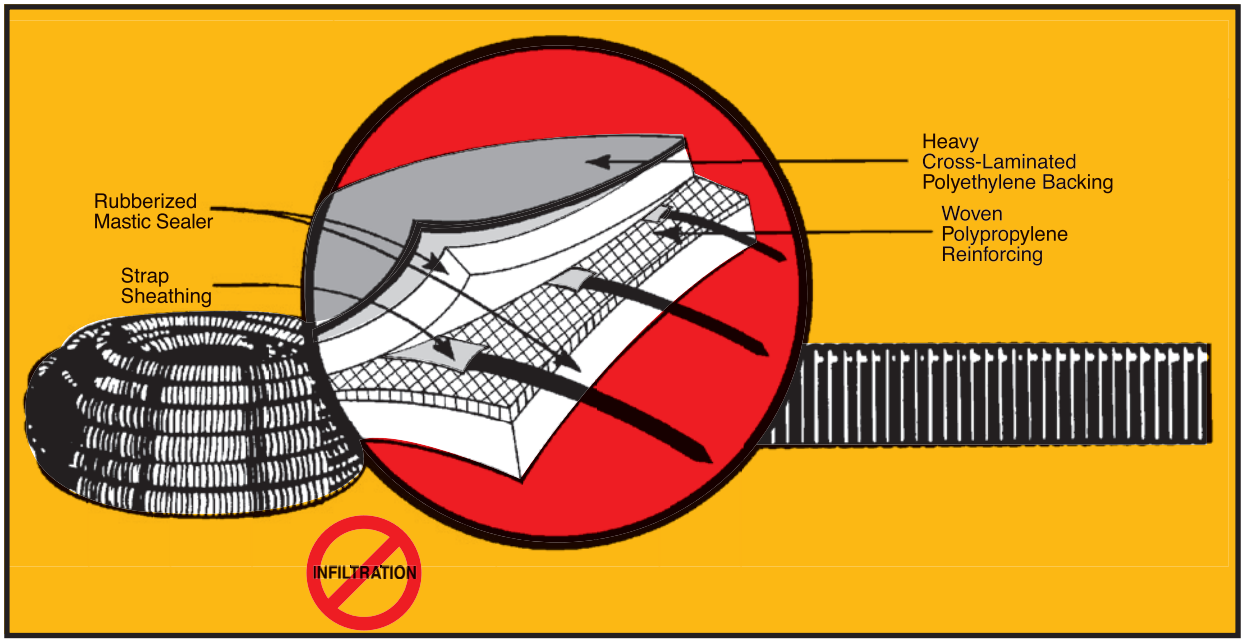
CPP Mastic Wrap Couplers for Non-Pressure, Leak Resistant Connections

c. **MASTIC WRAP COUPLER** offers non-pressure, water leak resistant pipe connections for gravity-flow sewers and storm culvert CPP pipe systems. Geotechnical Engineers should consider the use of these couplers in Class IV, V and N/R soil types as a precautionary measure against some future sink hole formation possibility due to soil-water migration. They are also required for continous water flows.

CPP wrap around style mastic couplers have an outer layer of cross laminated polyethylene plastic and an under layer adhesive surface of rubberized mastic material. In between these two surface layers is a high strength shear and puncture resistant layer of woven polypropylene. This center third layer provides toughness against puncture as well as stretch resistance under earth load shifts or settlements.

The Mastic wrap coupler from CPP is mechanically sealed by stainless steel screw type hose clamp compression bands. These adjustable compression clamp bands are easily secured using simple tools such as screwdrivers, nut drivers, or socket wrenches. Proper tension on these bands will provide a seal against infiltration and exfiltration in gravity flow, non-pressure pipes. Hose clamp compression seals are used on sizes twelve inch and larger while metal twist style compression ties are used on four inch through ten inch size pipes (see photo w/twist ties on page 23).

Each mastic coupler comes with three hose clamp compression bands or ties located within the coupler. There is one compression strap located in the butt joint corrugation pipe valley, and one strap in the first valley on each side of the butt joint. Proper compression tension on each strap (centered over a corrugation valley) will forcibly apply the mastic surface around the corrugation crests and walls to provide a seal. Enough tension should be applied to substantially sink the compression straps into the corrugation valleys below the corrugation crests in order to have a leak resistant seal. Prior to applying the mastic side to the pipe be sure to clean the pipe of soil/dust particles that could interfere with the mastic seal making contact with the pipe surface. CPP mastic couplers can also be used to couple corrugated pipes manufactured with different corrugation designs of the same pipe size as well as to couple CPP pipes to other pipes made from a different raw material base.

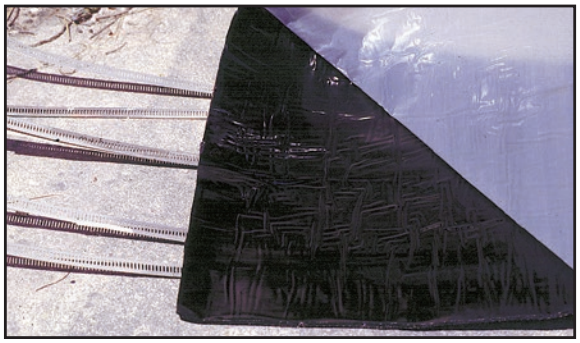


CPP Mastic Wrap Couplers for Non-Pressure, Leak Resistant Connections

HOW TO APPLY CPP MASTIC COUPLERS

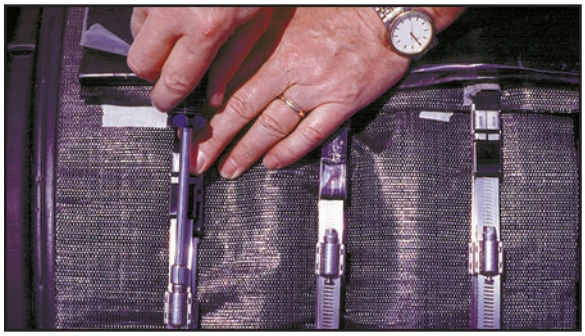
Step 1:

Clean the CPP pipe exterior to remove foreign matter that could interfere with the contact between the sealer and the pipe surface.



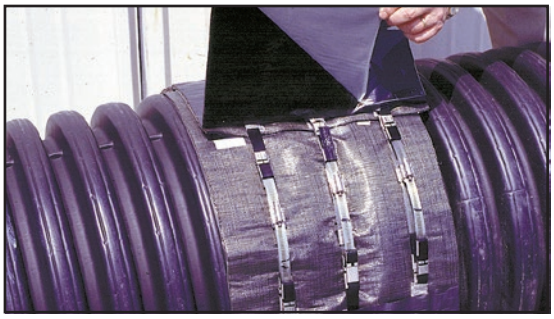
Step 2:

Remove the protective wax paper film to expose the rubberized mastic surface, and position the pipe on the mastic so the three compression bands will be centered over a pipe corrugation valley. To avoid getting new soil on the clean pipe or the coupler's mastic surface, the installer may wish to lay down a thin plastic sheet under the area to be joined. This will provide a clean working surface in the ditch or on the ground.



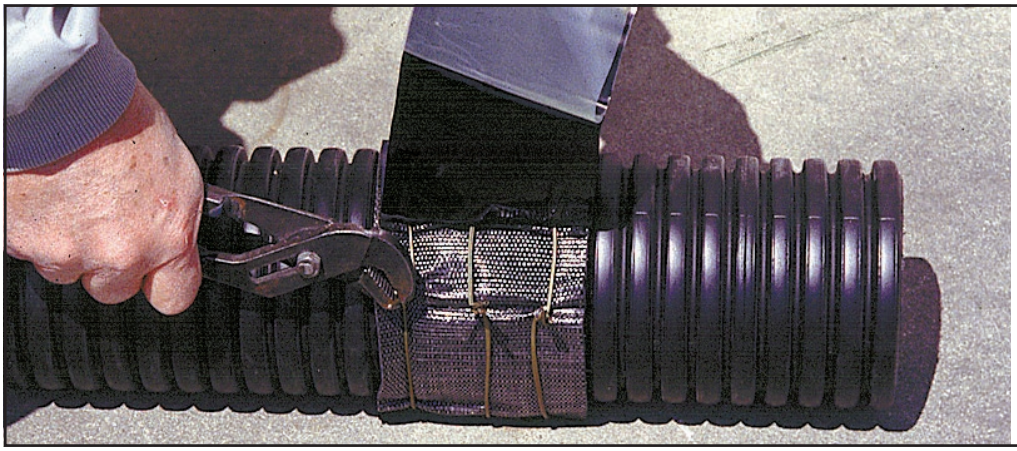
Step 3:

Using a screw driver, nut driver, or socket wrench (pliers or twist tie tool on twist style), tighten the straps. The outside straps should be tightened first.



Step 4:

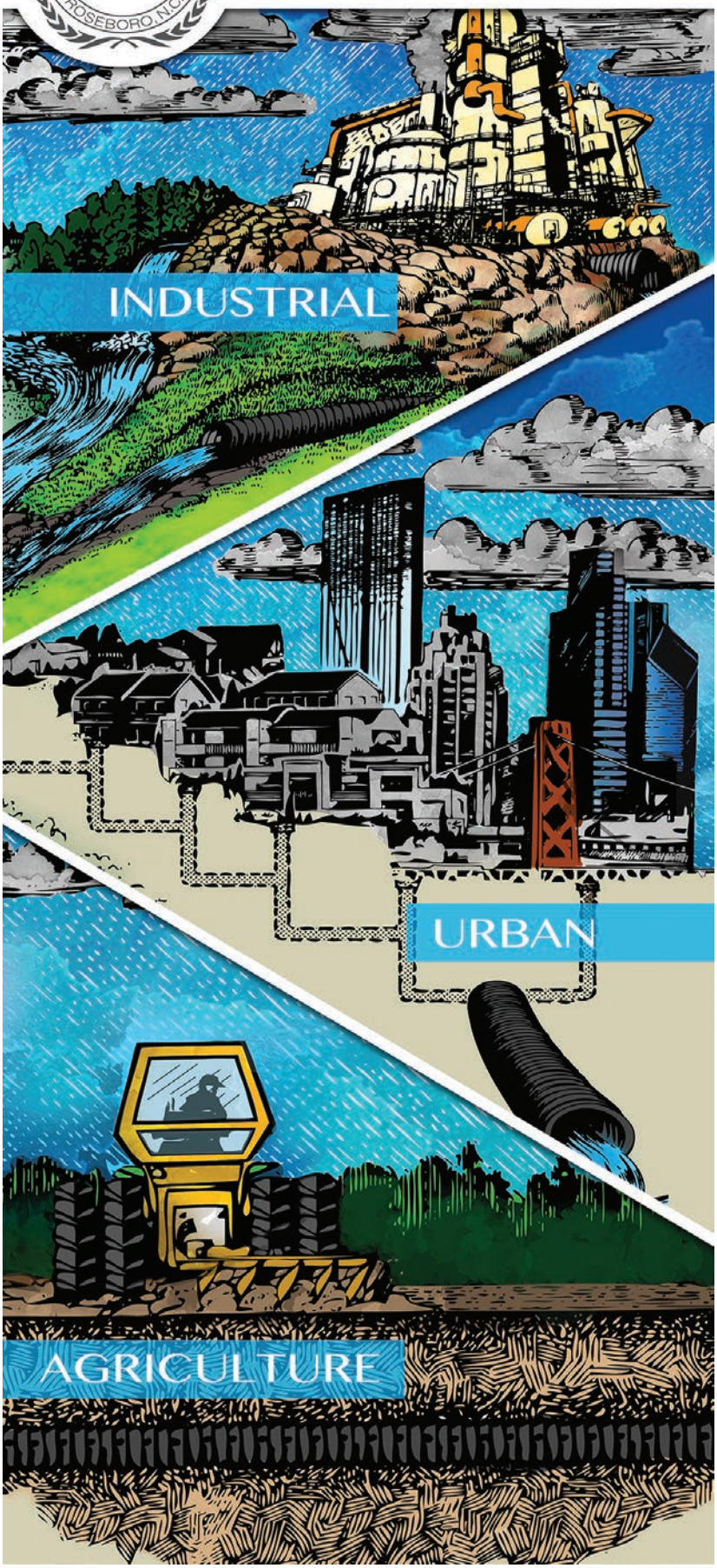
Remove the short section of protective film from the closing flap, and cover the exposed portions of the straps.



This Photo shows an example of the Twist-Tie style Compression Tie used on 4", 6", 8" and 10" size pipes.

CPP-PIPE.COM

STORMWATER TREATMENT

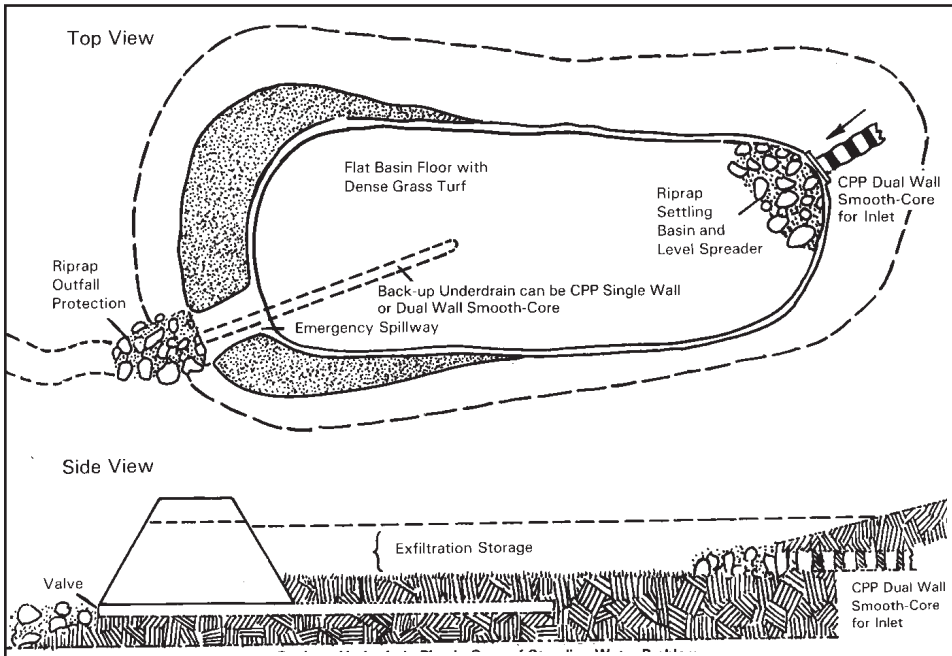


As Industrial, Urban and Agricultural development increase, society is left with more impervious roads, parking lots, airports, factories, municipal area buildings, open strip mines and bare farm fields all sloping toward outlet streams that are becoming more polluted because the land development process has stripped away nature's "Soil-Plant" filter system.

What follows are Stormwater BEST MANAGEMENT PRACTICE (BMP'S) examples for water quality run-off improvement. The three methods most used are: Infiltration, Detention and Vegetative or combinations of these.

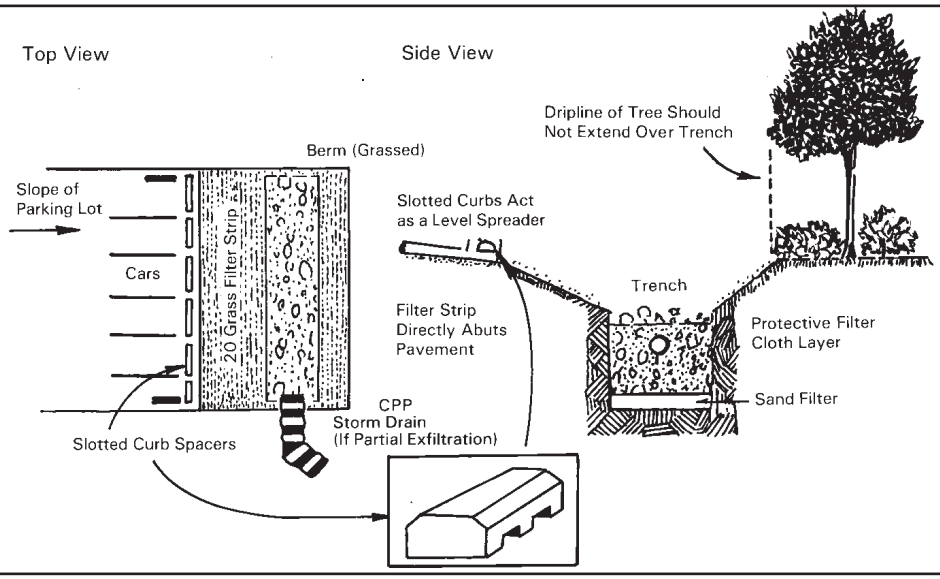
CPP pipe systems fit a BMP Stormwater Quality Improvement design because its inert, Non-Corrosive feature assures engineers that additional detention basins will not have to be built to treat chemicals or trace metals that can leach from corroding pipe walls made from base raw materials other than HDPE.

Controlled Drainage for Stormwater With CPP

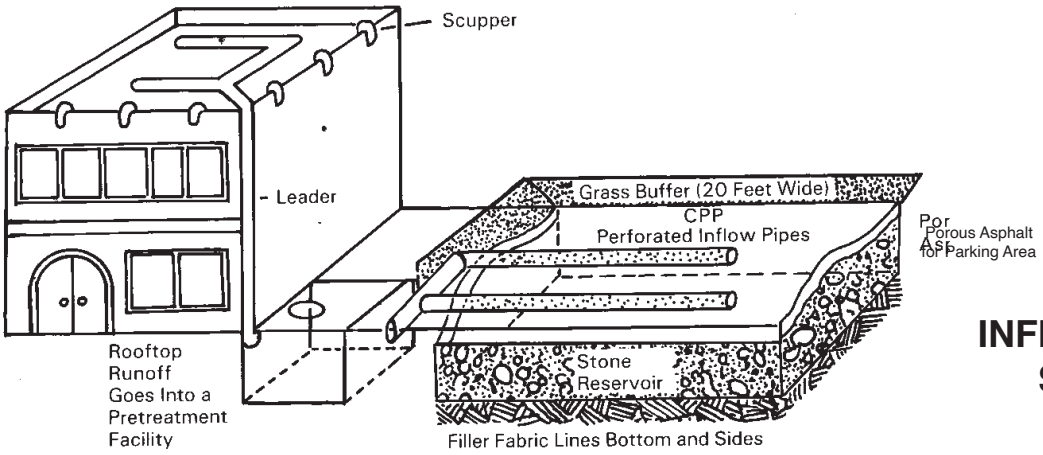


DETENTION with exfiltration

Back-up Underdrain Pipe in Case of Standing Water Problem can be CPP Single-Wall or Dual-Wall Smooth-Core



VEGETATIVE with infiltration



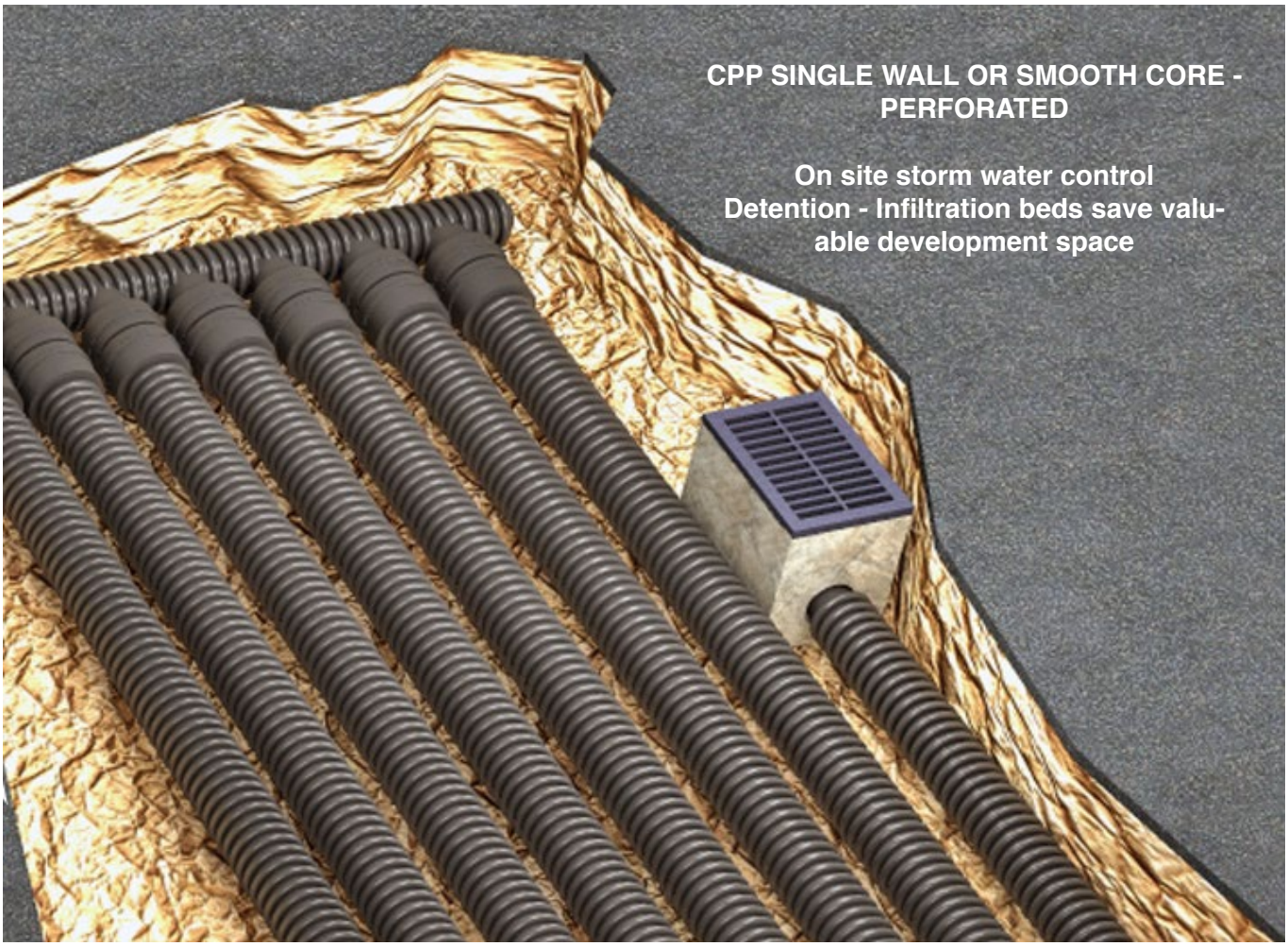
INFILTRATION System

To Spec (HDPE) Corrugated Plastic Pipe Spec as:

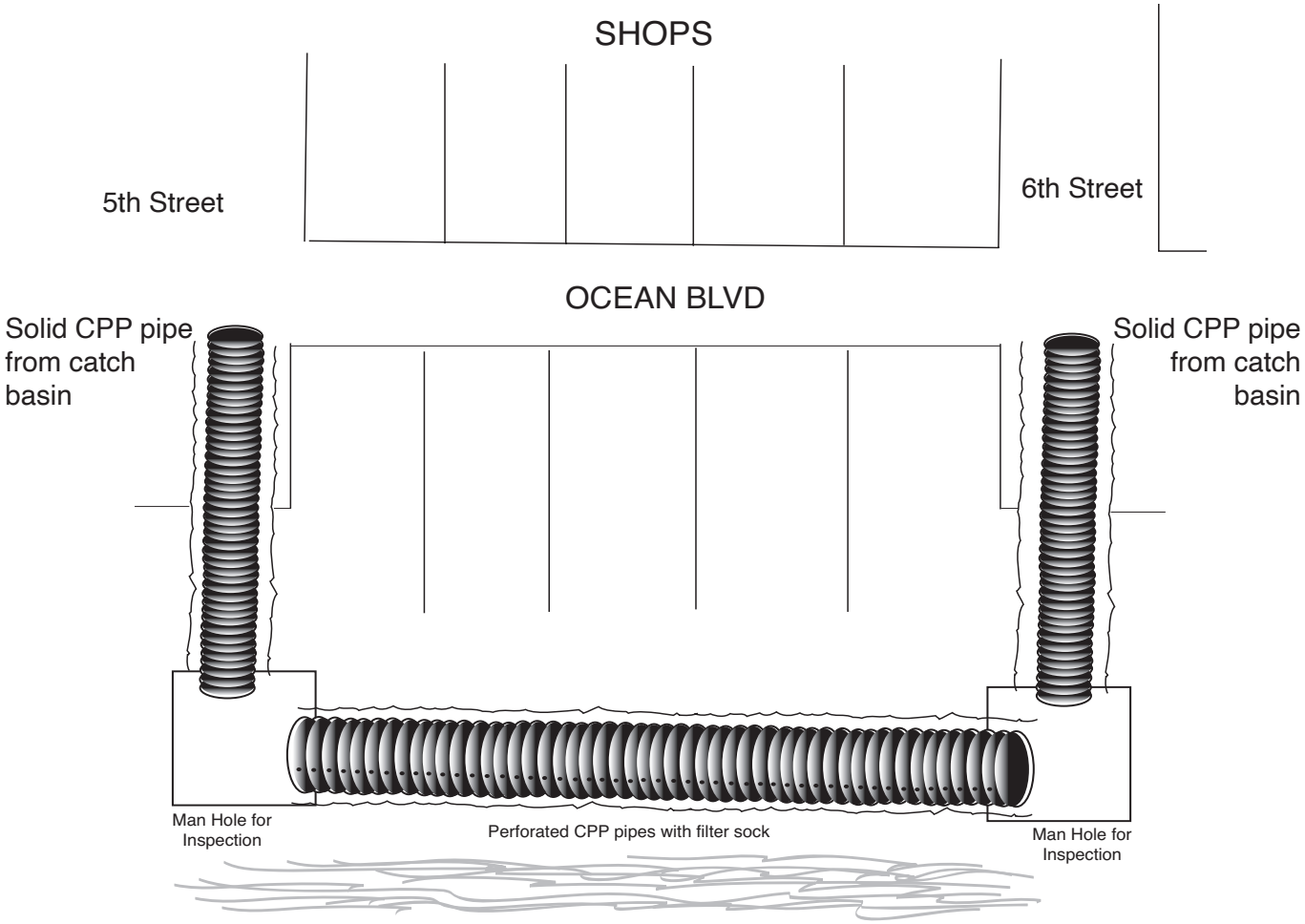
ASTM General Construction:
ASTM-F-677 (3” - 24”)
ASTM-F-2306 (12” - 60”)
ASTM -F2648 (2”-60”)

AASHTO Highway Construction:
AASHTO-M-252 (3” - 10”)
AASHTO-M-294 (12” - 60”)

Near zero deflection under traffic bearing pavement with CPP pipe systems can create great labor savings on large pavement jobs, and speed up construction schedules.

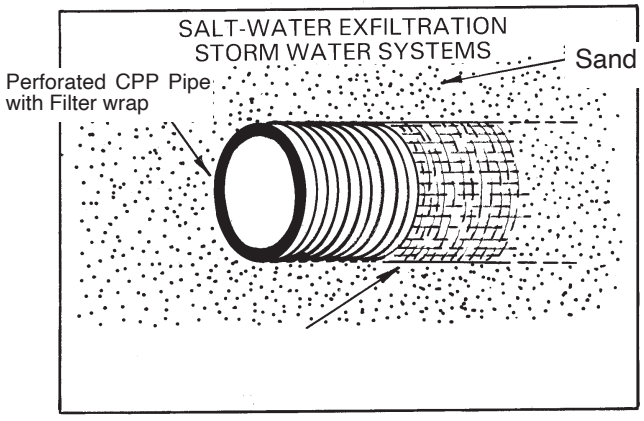


Salt Water Exfiltration Storm Water Control System



As ocean tides recede, storm water from street run-off rains can go out with the tides. This avoids beach erosion which often occurs when uncontrolled storm water from streets is deposited directly on top of non-cohesive sandy beach soils.

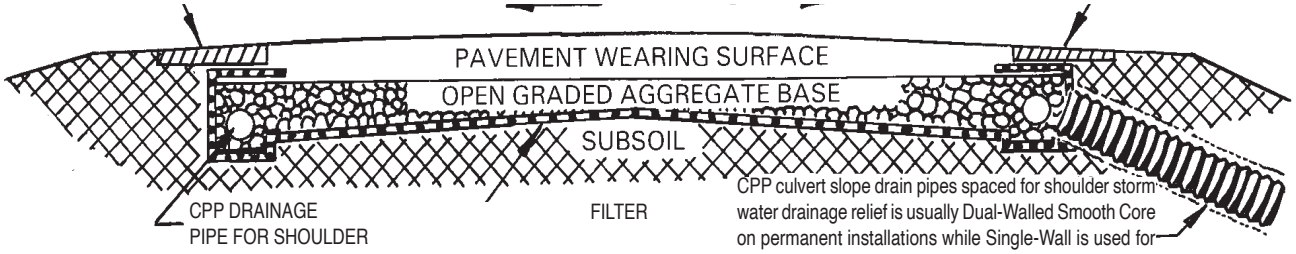
CLOSE-UP



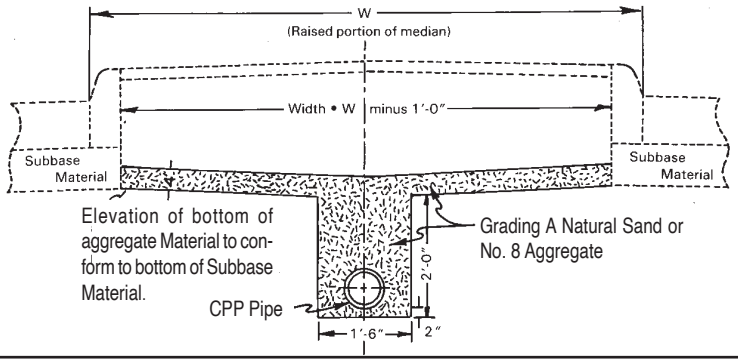
Waterborne fines are filtered out while water passes easily through the pipes filter wrap allowing CPP pipe to carry the maximum volume of water with very little siltation in sandy non-cohesive soils

Controlled Drainage Reduces Run-Off Pollution

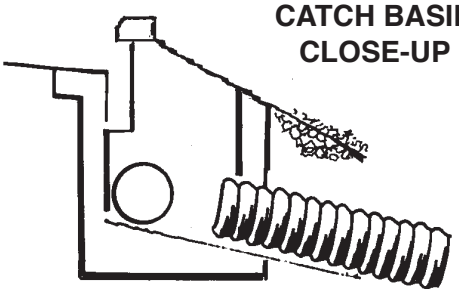
BASIC AIRPORT and HIGHWAY DESIGN CROSS SECTION



UNDERDRAINS FOR GRASS MEDIAN HIGHWAY STRIPS

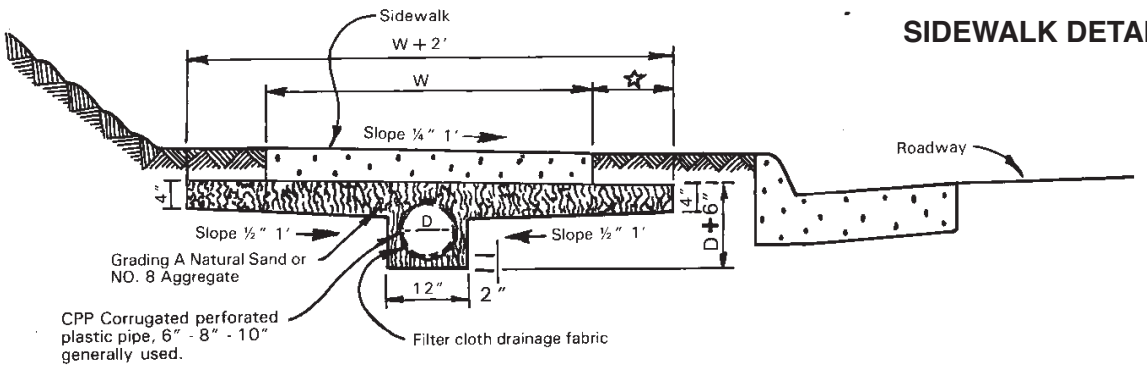


CATCH BASIN CLOSE-UP

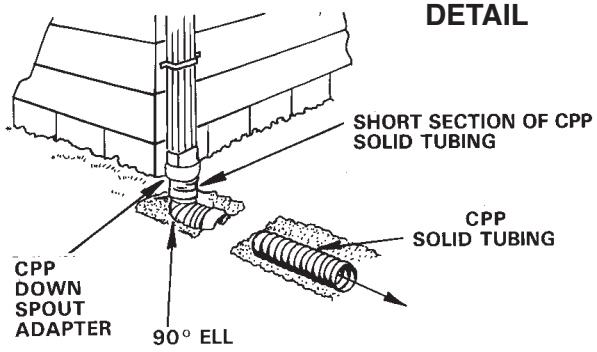


CPP pipe systems work well under curb and gutter catch basin systems and median drains.

SIDEWALK DETAIL

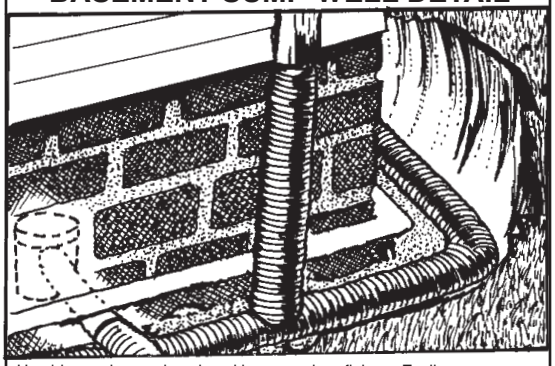


DOWN SPOUT DETAIL



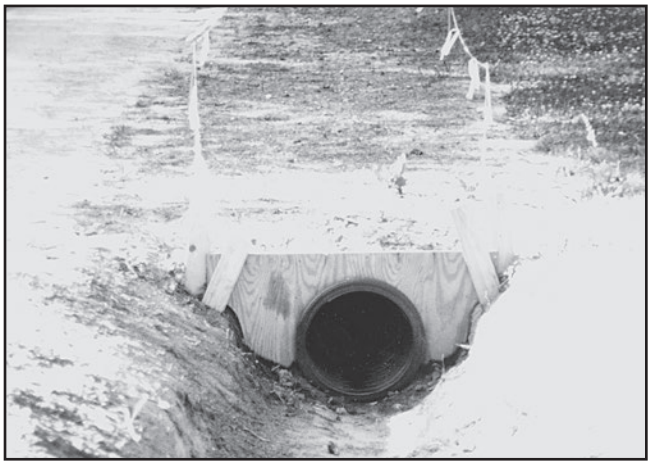
To carry rainwater away from the house and avoid water seeping down basement wall and creating wet basement problems, use solid tubing from downspout to surface inlet, dry well, or other disposal area.

BASEMENT SUMP-WELL DETAIL

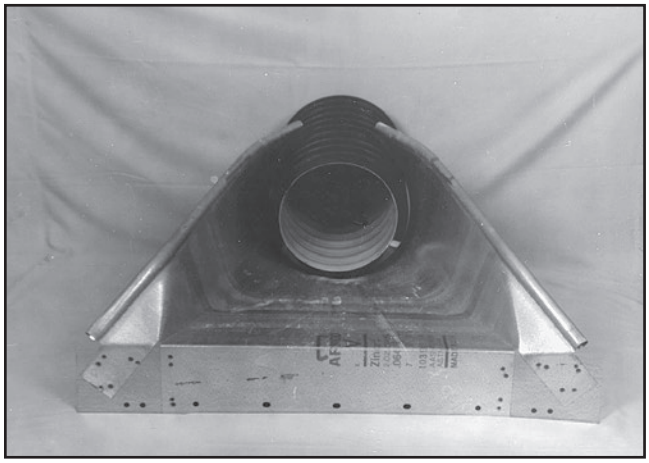


Used in continuous lengths with appropriate fittings. Easily connects to sump wells and community drain systems to eliminate flood conditions.

Concrete catch basins are easily formed around corrugated pipes of all sizes.



On-site concrete head walls are easily poured behind plywood forms to prevent erosion, and to offer exposure protection to plastic pipes as also done with concrete or metal pipes lined with plastic or tar coatings. Continuous water flows require Headwalls with Wings to ease water flow that reduces negative vacuum pressure.



Commercially available metal flared-end sections also fit CPP pipes offering pipe exposure protection along with bank erosion protection.

While stone larger than 1½" are prohibited in the loadbearing zone, they are an attractive landscape alternative to concrete or asphalt headwalls and metal flared end sections. All offer excellent protection to CPP pipes from potential gang-mower damage or the burn off of thick ditch bank Fall brush.

Adapts to conventional loadbearing catch basin systems

Class I rock and marl hand compacted keeps CPP pipe culverts well supported at the sides and above.

Hydraulic Flow

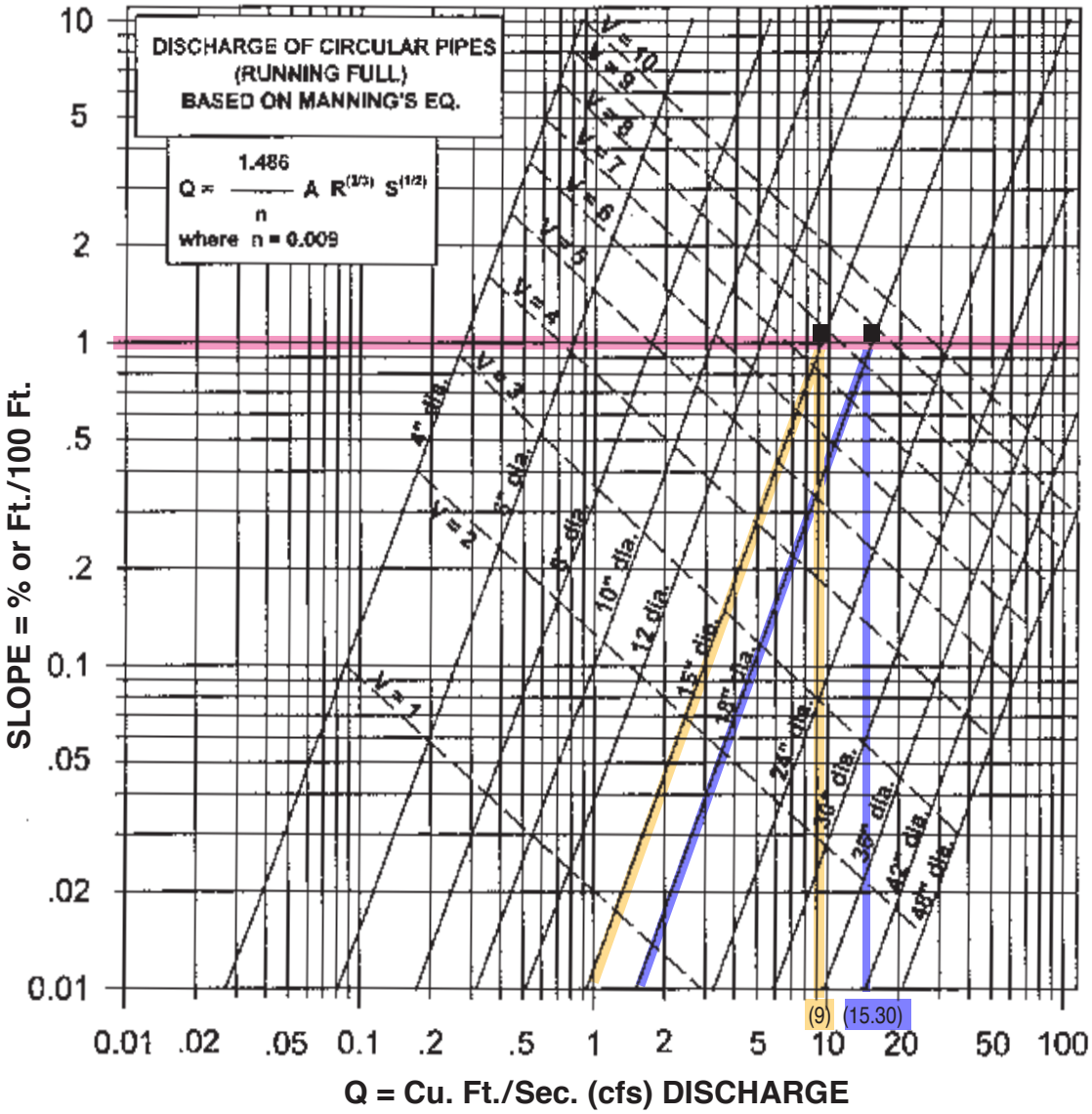
CPP pipes are made of HDPE plastic raw material, which has a non-wetable, glass-smooth surface that makes it possible to use a MANNING COEFFICIENT OF FLOW VALUE of n=0.009 as shown on the graph below.

The GRAPH values for VELOCITY in feet per second (V), and for FLOW DISCHARGE in CUBIC FEET PER SECOND (Q) are based on the HDPE raw material ROUGHNESS FACTOR (n) of 0.009. Because the pipe manufacturing process of temperature and melt flow may or may not effect pipe surface roughness, CPP selects n=0.010 as its base n factor for laboratory preconstruction pipe hydraulic flow estimates on CPP SMOOTH-CORE. CPP SINGLE-WALL n values will vary according to pipe size, and are shown on the CHART following. The installed n values for 12" and larger may vary from 0.011 – 0.014 depending on expected sediment loading and installation expertise. If it is desired to convert the GRAPH values to other n values as shown on the CHART below, one should divide the GRAPH values as follows:

0.009)

1.111 for n of 0.010
1.444 for n of 0.013
1.555 for n of 0.014
1.666 for n of 0.015
1.888 for n of 0.017
2.000 for n of 0.018
2.222 for n of 0.020

Hydraulic Flow



FLOW RESRICTION "N" VALUE CHART

DIAMETER	CPP'S SINGLE WALL	GALVANIZED CORRUGATED	CPP'S SMOOTH CORE/N-10	CONCRETE
4"	0.014	N/A	0.010	N/A
6"	0.014	N/A	0.010	N/A
8"	0.015	0.022 – 0.026	0.010	0.011 – 0.015
10"	0.017	0.022 – 0.026	0.010	0.011 – 0.015
12"	0.018	0.022 – 0.026	0.010	0.011 – 0.015
15"	0.018	0.022 – 0.026	0.010	0.011 – 0.015
18"	0.020	0.022 – 0.026	0.010	0.011 – 0.015
24"	0.020	0.022 – 0.026	0.010	0.011 – 0.015
30"	N.A	0.022 – 0.026	0.010	0.011 – 0.015
36"	N/A	0.022 – 0.026	0.010	0.011 – 0.015
42"	N/A	0.022 – 0.026	0.010	0.011 – 0.015
48"	N/A	0.022 – 0.026	0.010	0.011 – 0.015

To convert graph discharge of Cu. Ft./Sec. to Gal./Min. multiply by 448.8.
To convert graph discharge of Cu. Ft./Sec. to Gal./Day multiply by 646,358.

Hydraulic Flow

The INERT, ANTI-ADHESIVE nature of HDPE also assists CPP pipes in their excellent hydraulics because it prevents the SCALE-SLIME-SEDIMENT build-up that is common to pipes made of other materials. Pipe flow discharge rates for any gravity flow pipe system is determined by the MANNINGS FLOW equation. The "n" value in this equation for ROUGHNESS COEFFICIENT is shown in the chart on the previous page.

Mannings Equation

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

where
Q = flow (cfs)
n = Manning's "n", a term used to describe material roughness (unitless)
A = cross-section flow area of the pipe (ft^2)
R = hydraulic radius (ft.), ¼ the diameter for full-flowing circular pipes
S = pipe slope (feet/foot)

In using any pre-construction estimates concerning pipe hydraulics, one must keep in mind that pre-construction flow estimates depend greatly on the "state-of-the-art" knowledge of the installer, and how closely to grade he positions pipes, manholes or applies couplers, etc. In addition, the amount and type of sediment expected in the fluid flow can alter installed n-calculations. In gravity-flow pipe systems there are many things that are encountered in the field that can revise a laboratory environment water flow calculation. The pre-planning stage as well as the construction stage of a project should take into account all the possible variables. While some of the more tightly controlled manufactured concrete pipes may show an initial roughness coefficient that is equal to an HDPE pipe when first installed, the durability of HDPE over time will cause its roughness coefficient not to vary or increase with wear since the chemically inert HDPE is less effected by pitting and corrosion. This in turn will reduce maintenance and replacement costs over the years. Because the "n" factor will remain more constant over the years than the "n" factor of competing pipe raw materials, DOWNSIZING with CPP'S SMOOTH-CORE n-10 on flat grades can be possible. Using smaller size CPP pipes at steeper grades to achieve higher flow rates is also possible because HDPE raw material based pipes are more abrasion resistant than competing raw material based pipes.

French and Farm-Landscape Sub-Surface Drain Hydraulic Notes

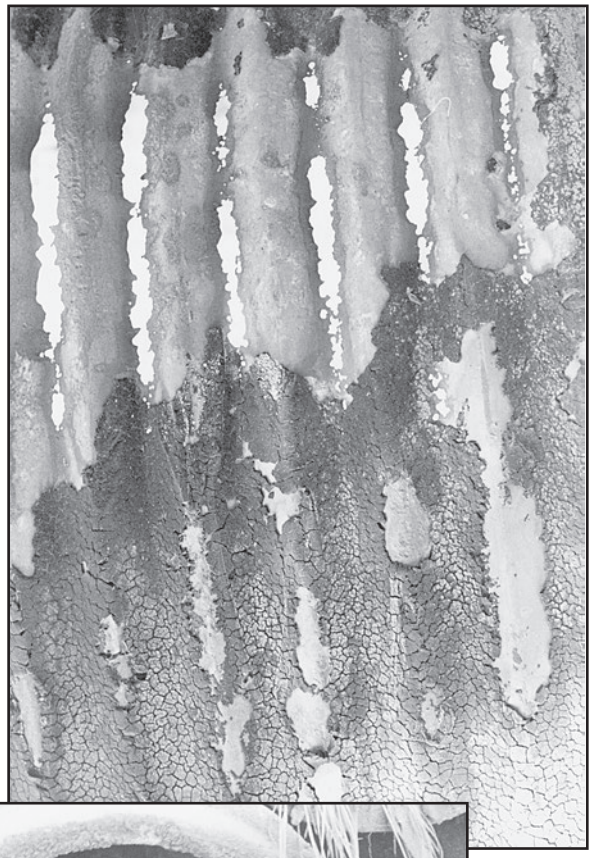
In gravity flow drain pipe systems the grade of the pipe greatly determines the water flow velocity as the included HYDRAULICS GRAPH and CHART indicate. Another important hydraulic factor to consider is the opportunity that water may or may not have for entering into a pipe system. INLET DRAINS and CATCH BASINS are structure devices for improving the opportunity of water to enter a pipe from above ground. In slow-soak, leach filtering subsurface gravity drain pipes, the rate of water entry is to a small degree determined by the INLET AREA sizing of perforations (slots or round holes) in the pipe. The most important water inlet control factor for subsurface drain pipes however is the PERCOLATION RATE (PERC RATE) at which water filters, oozes or trickles through a particular soil type profile. Water will not filter or perc through a heavy, stiff clay soil as fast as it will through a sandy or gravel soil type. Local Farm Officers or Soil Conservation Service Engineers can supply general soil perc rates. At sites with several different soil types, soil perc rates can be complex to discern and even unknowable. To speed up a soil's perc rate in a stiff or complex soil, rock or sand is often placed around a perforated underdrain pipe. This technique is also used in house basement perimeter subsurface drains. A filter between the rock and the native site soil will prevent the native site soils from migrating with a subsurface water flow into the rock, and thus over time plugging up the rock rendering the rock-pipe system useless. If sand is used as a perc rate enhancer, a filter is generally applied directly to the pipe to prevent sand fines from entering the pipe. These underground rock or sand pipe systems are sometimes called "French Drains", and do not require the maintenance of trash removal from metal grates that a Catch Basin inlet system does. However, in very slow perc rate soils, some type of ground level, surface flow Catch Basin or Inlet Flow Drain structure may be required for improving the opportunity of water to enter a pipe system. Any good drainage system of any size will generally require a balance of both surface and subsurface drainage capability in order to handle both flash-flood rain events, and also long term soaking rain events.

Metal & Concrete Breakdown

Pipes of all raw material bases can have an appropriate place in the engineering scheme of designing longer lasting, more serviceable pipe systems if correctly subjected to LIFE-CYCLE COST ANALYSIS for a particular project site.

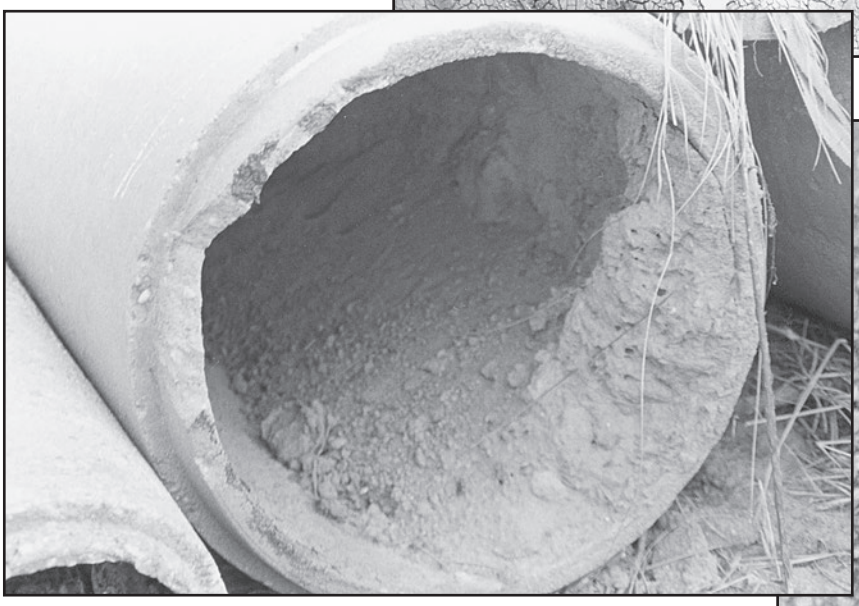
CPP corrugated HDPE pipe systems will last through the depreciation of a project built where there are corrosive soils and waters, or abrasive sediment flows.

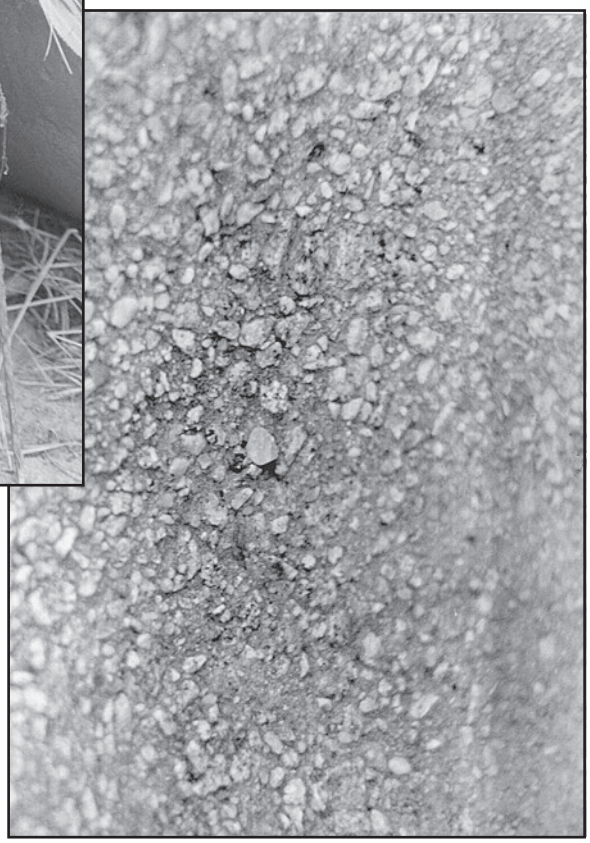
For insurance, DO THE JOB RIGHT THE FIRST TIME by specifying CPP pipes in your chemical HOT SPOTS for longer lasting pipe systems.



Sediment abrasion of metal pipes bituminous coating is stripped away by stormwater sediment abrasion, and holes are eventually corroded into the walls. Leaking pipes invite more sediment into the pipe system, and trench wall support is lost.

As abrasion roughs up the surfaces of concrete and metal pipes, flow resistance (n-numbers) will increase. Abrasion resistant CPP will maintain a more constant flow resistant n number over the life of a project.





Photos show how sediment buildup in concrete pipes abrade away the smooth surface of the pipe wall. This sand paper action will eventually wear down to the reinforcing wire, and structural failure will occur. Cracked or chipped coupling joints as shown here also play a big role on inviting sediment into a pipe system. This abrasion/corrosion process often causes road bed-pavement washout failure to occur in less than the fifty year life span that State Hwy. Departments try to achieve in their road construction designs.

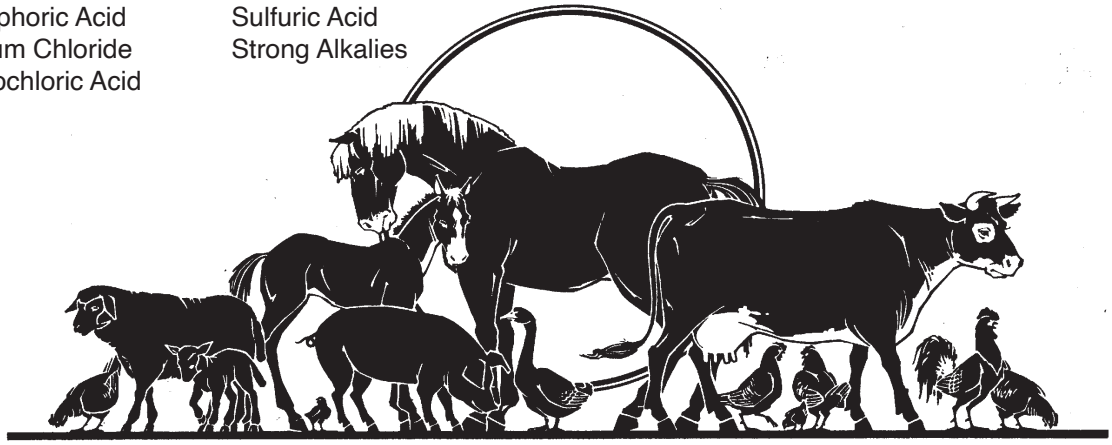
Waste Water Treatment Applications

CHEMICAL RESISTANCE

HDPE is the most chemically inert of all plastics, thus making CPP'S corrugated pipe systems corrosion resistant. According to MODERN PLASTICS ENCYCLOPEDIA Magazine's chemical resistance charts for HDPE molding and extrusion grade plastics, HDPE has good resistance to a number of chemically active solutions including the following:

Acetic Acid
Allyl Alcohol
Phosphoric Acid
Sodium Chloride
Hydrochloric Acid
Chlorine
Nitric Acid
Sulfuric Acid
Strong Alkalies

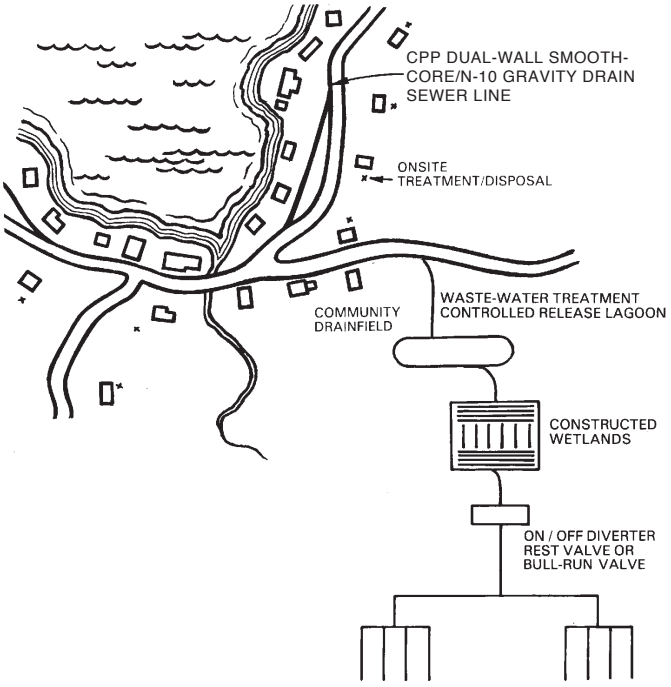
In addition to the above information, corrugated HDPE pipes have been used since 1968 in home septic systems thus showing good resistance to raw sewage with its composition of caustic household soaps and brighteners, and is unaffected by a pH range from 1.5 to 14. For a chart detailing the suitable or unsuitable uses of HDPE CPP pipes in over 200 chemical environments, please call our TOLL-FREE WATS.



INDUSTRIAL WASTE WATERS

The inert chemical quality of CPP HDPE raw material based pipe systems provides corrosion resistant pipes that provide engineering solutions to a variety of pH waste waters in Industry, Agriculture and Municipal areas. Among these are industrial corrosive waste

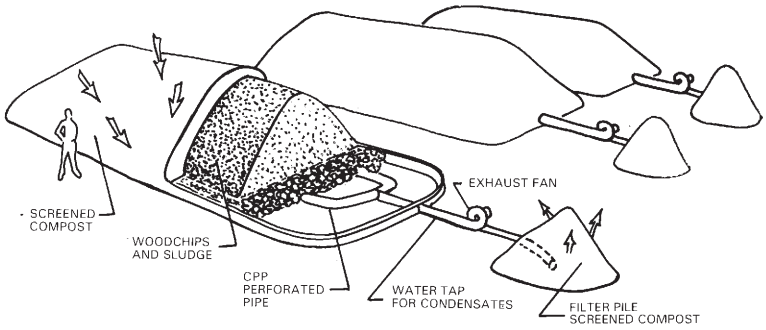
SMALL COMMUNITY WASTE WATERS



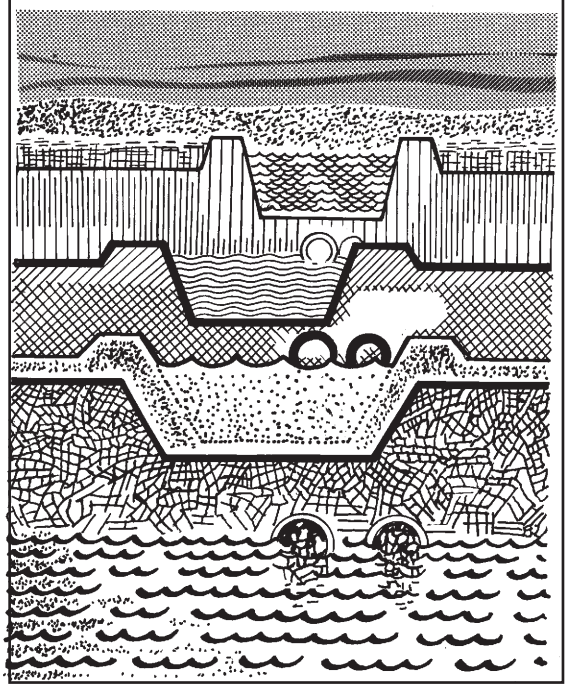
water; Sewer sludge de-watering; Landfill drainage and gas relief; Sand filter sewer treatment; Built-up wet land sewer treatment and agricultural animal husbandry waste water treatment systems.

Corrosion Resistant Waste-Water CPP Systems

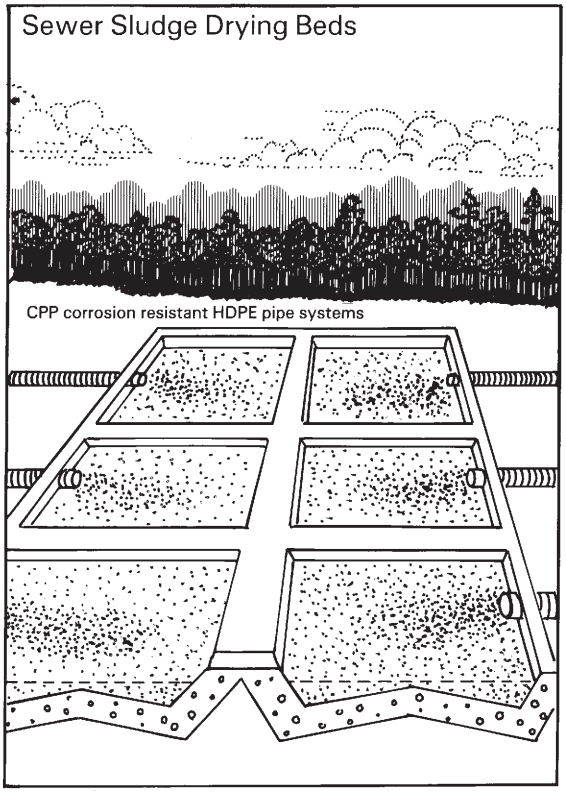
Aerated Compost Sewer Sludge Pile



Waste-Water Controlled Release Lagoons

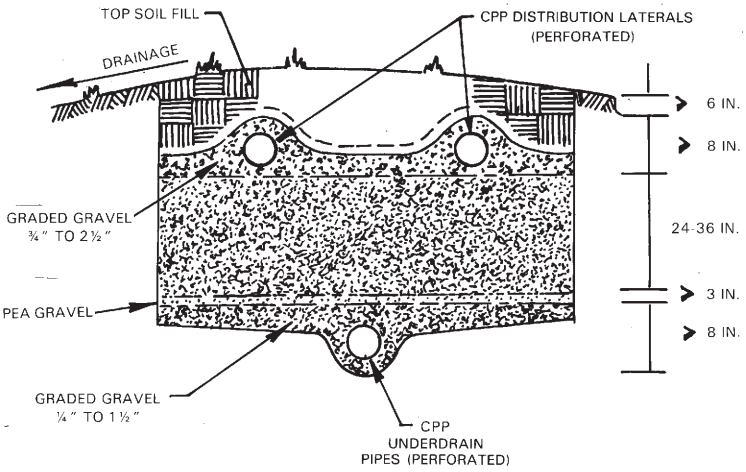


Sewer Sludge Drying Beds



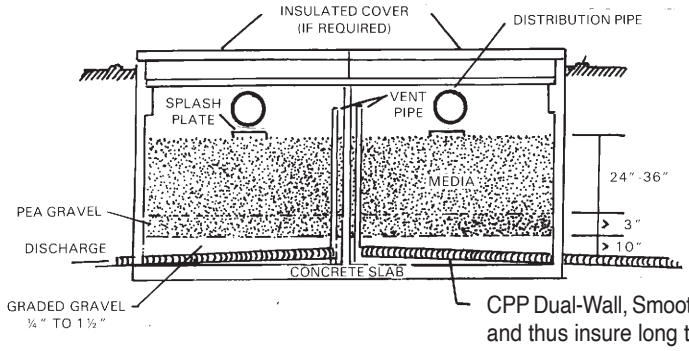
CPP Dual-Walled Smooth-Core/n-10

Buried Sand-Pebble Filter Systems Use CPP Dual-Wall, Smooth-Core/n-10



Open Sand Filter

CPP Dual-Wall, Smooth-Core/n-10 Septic or Furrow perforated assure even, corrosive free distribution



Chemically inert HDPE CPP pipes used for inlet and outlet pipes in waste water treatment sand-pebble filter systems will maintain essential pH control of effluents, whereas pipes made from raw materials other than HDPE can leak unwanted elements into effluents over the long term.

CPP Dual-Wall, Smooth-Core/n-10 perforated collection/Discharge pipes are corrosion resistant, and thus insure long term velocity discharge rates better than pipes that are corrosion prone. Corrosion prone pipes pit over time, and as "n" factors increase velocity rates will decrease. CPP pipe systems insure more stable long term "n" factors for engineers and planners.

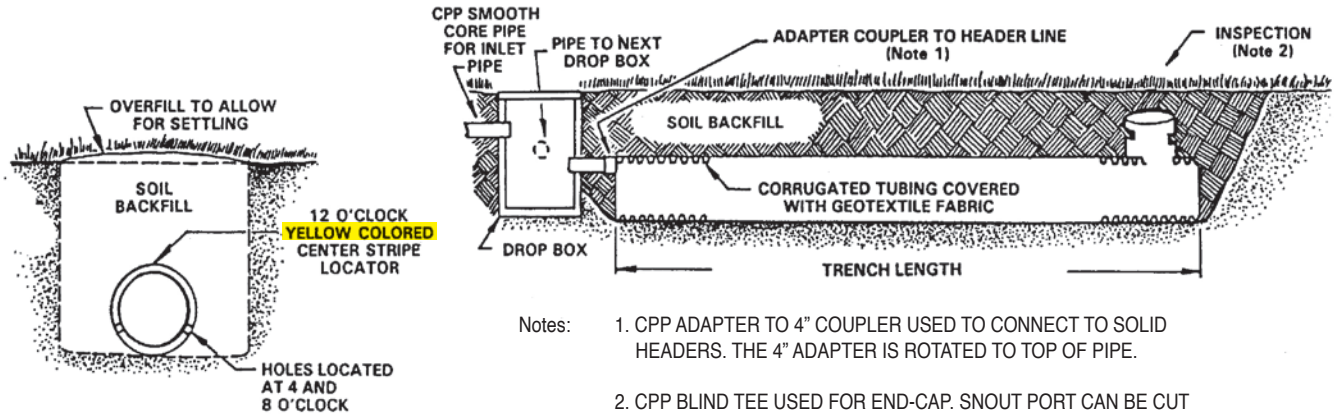
Crumpler's No-Rock™ Fabric Wrapped Large Diameter (LDP) Septic Pipe

Blind Tee's

Tee With Cleanout

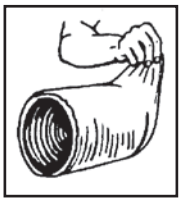
Snap Combo End Cap/4" Reducer/Adapter

CPP No-Rock™ LDP Trench Construction Details



Notes:

1. CPP ADAPTER TO 4" COUPLER USED TO CONNECT TO SOLID HEADERS. THE 4" ADAPTER IS ROTATED TO TOP OF PIPE.
2. CPP BLIND TEE USED FOR END-CAP. SNOUT PORT CAN BE CUT OUT FOR INSTALLING A CLEAN OUT ADAPTER THAT ALLOWS FOR POST INSTALLATION INSPECTION.



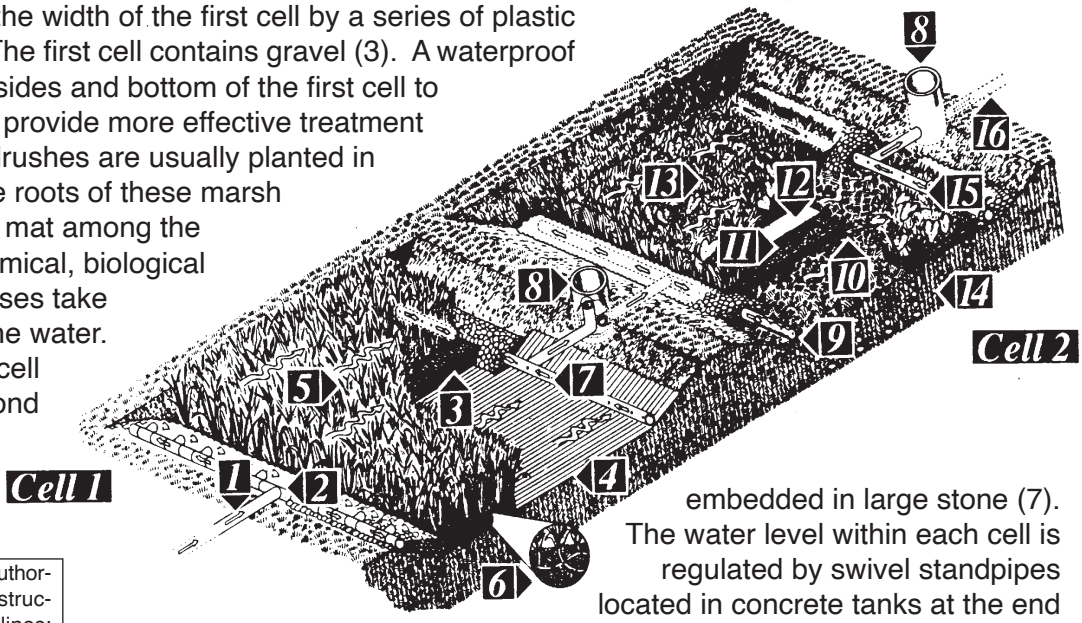
TYPE	SIZE	PART NO.	PACKAGE DESCRIPTION	PRICE
	8"	0830020B	CRUMPLER'S NO-ROCK™ SEPTIC - 20 ft. with filter wrap	
	10"	1030020B	CRUMPLER"S NO-ROCK™ SEPTIC - 20 ft. with filter wrap	

Large diameter (LDP) CPP **No-Rock™** septic tank trench systems use a filter wrap that allows for the installation of septic treatment pipes without gravel. The advantage in using CPP NO-ROCK is evident in areas where there is a shortage of inexpensive quality rock or where the shape and topography of a lot hinder the access of heavy construction equipment. Less equipment use means more trees can be saved, less lot grading is needed, and thus fuel and labor are saved. Additionally, 8" and 10" pipes create reduced On-Center (**OC**) spacing between more narrow parallel septic trench lines. **An 8" pipe will fit into a 10" wide trench and a 10" pipe in a 12" wide trench. This allows for a 5 foot OC spacing for 8" and a 6 foot OC for 10".** Thus lot space is saved for other uses.

- **Eliminates Rock**
- **Saves On Lot Grading**
- **Saves Trees On Lot**
- **Saves on Installation Labor**
- **Saves Fuel**
- **Increases Lot Value**

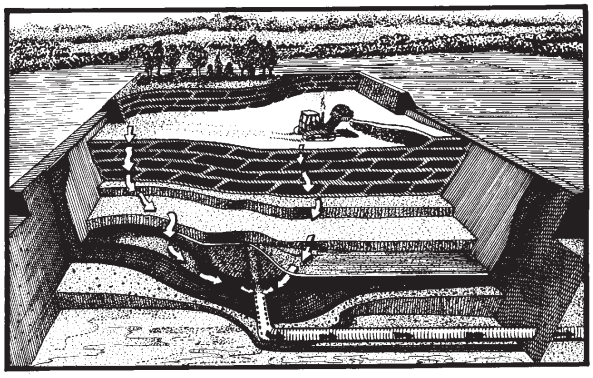
Typical Constructed Wetlands

Wastewater enters the constructed wetland (1) where it is distributed evenly across the width of the first cell by a series of plastic valves or tees (2). The first cell contains gravel (3). A waterproof liner is used on the sides and bottom of the first cell to conserve water and provide more effective treatment (4). Cattails and bulrushes are usually planted in the first cell (5). The roots of these marsh plants form a dense mat among the gravel (6). Here chemical, biological and physical processes take place which purify the water. Water from the first cell passes into the second cell through a CPP perforated pipe embedded in large stone (7). The water level within each cell is regulated by swivel standpipes located in concrete tanks at the end of each cell (8). Wastewater in the second cell is distributed evenly across this cell through another CPP perforated pipe (9). Cell 2 has a layer of gravel (10) covered with topsoil (11) and then mulch (12). This cell is planted with a variety of ornamental wetland plants such as iris, elephant ear and arrowhead (13). The water in Cell 2 eventually seeps into the soil below (14) or passes into another CPP perforated pipe (15) where it is released into a CPP pipe drainfield similar to those used with conventional septic tanks (16).



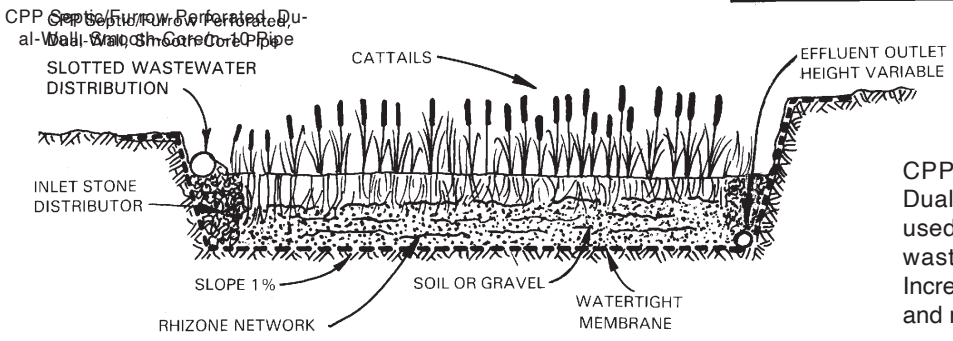
Source: Tennessee Valley Authority's General Design, Construction, and Operation Guidelines: Constructed Wetlands Wastewater Treatment Systems for Small Users Including Individual Residences.

CPP Corrosion resistant pipes are used in Landfill Leachate pipe systems because landfill leachate flow strengths change radically across the pH scale and frequently.

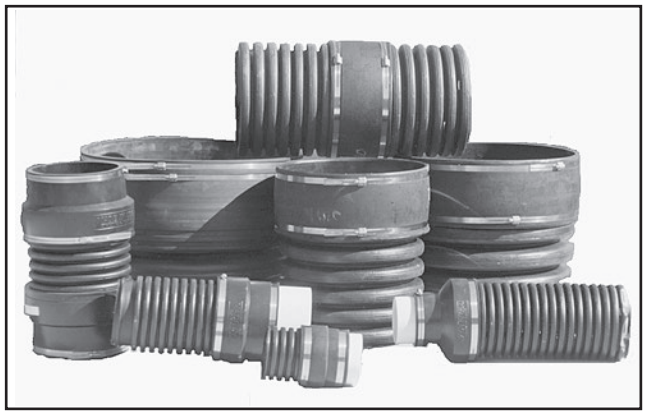


Constructed Wetlands

Overland Flow, Rapid Infiltration Sewer Treatment System Scheme



CPP Corrosion Resistant Perforated Dual-Walled, Smooth-Core/n-10 Pipes used as outlet pipes insure long term wastewater velocity discharge rates. Increased velocity increases re-aeration, and reduces hydrogen sulfide build up.



Waste water treatment systems often need gravity flow water leak resistant couplers and adapters. Fittings and adapters available for connection to existing pipe systems made from other raw materials.

Perforated CPP pipe systems used in BUILT-UP wet land or SAND-PEBBLE FILTER small community, individual, industrial or agricultural sewers adapt to other pipe systems with gravity flow, water leak resistant couplers.

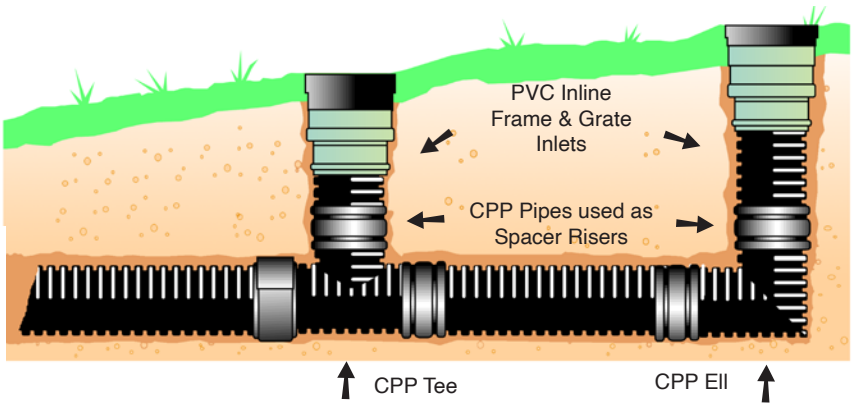
Waste water perforated pipe under low pressure evenly distributes water over built up wet land treatment system.

Swine house in background uses CPP DUAL WALL SMOOTH-CORE/n-10 to convey waste water to treatment lagoon.

Cut-off gate valves are often needed to regulate small waste water treatment systems. Gravity flow, water leak resistant couplers are available for environmental protection from leakage where needed.

CPP pipes also fit commercially available preformed loadbearing manholes commonly used in waste water treatment systems.

Surface Drainage Inlets & Outlets



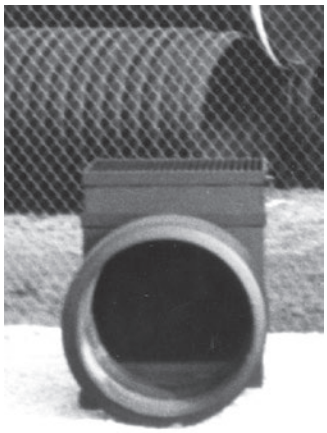
Surface Inlet Drain Schematic

Hinged grates available in 12” and 15” with inlet Drain Frames.

PVC Inlet Drain Frame and round grate available from 4” to 48”.

Inlet Drain frame and grate ready for paving and/or seeding.

Landfill stormwater treatment wetlands utilize corrosion resistant HDPE CPP.



Stormwater Catch Basin

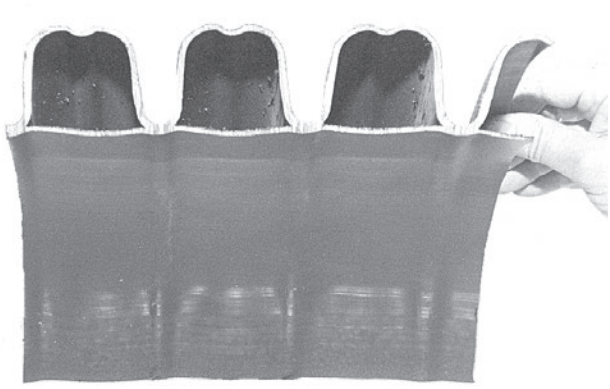
CPP HDPE Flared Ends for **Exit Flows**

CPP HDPE Headwalls for **Entry Flows**

CPP HDPE Flared Ends in combination with Cap Stone at the water discharge end stabilizes erosion before and after site work seeding and paving.

Quality Control Manufacturing

CPP Pipes tested to ensure quality control manufacturing.



Cut-Away of CPP SMOOTH-CORE/n-10 shows the Dual Wall with Smooth interior Feature that Engineers prefer for a superior hydraulic flow.

Technical Data

CRUMPLER'S corrugated plastic pipe and accessories meet and exceed all specifications concerning corrugated plastic pipe. These specifications include:

ASTM-F-667 for 3" -24 " Sizes	Building trade specs.
CS-226	for septic tank lines
ASTM-F-2306 for 12" - 60" Sizes	and foundation drainage.
ASTM-F-2648 for 2" - 60" Sizes	Sanitary Sewers

The specifications cited above are accepted by BOCA, ICBO, SBCC & IAPMO

SCS-606	Farm drainage specs.
AASHTO-M-252 for 3" - 10" Sizes	Highway drainage specs.
AASHTO-M-294 for 12" - 60" Sizes	Highway drainage specs.

The pipe manufacturing specifications listed above call for corrugated plastic pipes and culverts to be extruded from an HDPE (High Density Polyethylene) Type III; Category 3, 4 or 5; Grades P-33 or P-34; Class C Polymer resin as described in ASTM-F-2306 additionally calls for an HDB resin.

Both CPP Single-Wall and CPP Dual Walled, Smooth-Core/n-10 meet the same AASHTO pipe standard cited above. The two styles are differentiated by the addition of the letter "c" or the letter "s" at the end of the spec number. The "c" indicates a corrugated inside, while the "s" indicates a smooth inside surface. Similarly, the letters "cp" indicate a corrugated interior pipe that is perforated, while "sp" indicates a smooth interior perforated.

CPP pipes can be made with up to 100% recycled content per the test criteria established in ASTM-F-667, AASHTO-M-252/294, SCS-606.

Other Specifications:

ASTM-D-2321, ASTM-F-477, ASAE-EP 260.3, ASTM-F-1417, AASHTO-T-99, ASTM-D-3212, ASTM-F-2487

Visit PPI for More Information at **http://www.plasticpipe.org/drainage/**

REFERENCES INCLUDE:

"Strength-to-Weight and Hydraulic Flow characteristics of Smooth Lined corrugated PE Plastic Pipe" technical paper presented at the Fifth International Workshop on Land Drainage, Ohio State University, December 8, 1987.

"Maximum Allowable Fill Height for corrugated Polyethylene Pipe" Report to the Corrugated Plastic Pipe Association by Dr. Michael G. Katona, February 1987.

"Minimum Cover Heights for HDPE Corrugated Plastic Pipe Under Vehicular Loading" Report to the Corrugated Plastic Pipe Association by Dr. Michael G. Katona, November 1988.

"CORRUGATED PLASTIC PIPELINE" (NEWS), June 1989 Premiere issue published by the CORRUGATED PLASTIC PIPE ASSOCIATION.

"Abrasion Resistance of Polyethylene and Other Pipes" Report to the CORRUGATED PLASTIC PIPE ASSOCIATION" by Dr. L.H. Gabriel, P.E., Department of Engineering, California State University, Sacramento, Cal. 95919, October 24, 1989.

"CORRUGATED PLASTIC PIPELINE" (NEWS), March 1991 issue published by the CORRUGATED PLASTIC PIPE ASSOCIATION.

Reprints of the above are available upon request.

To Spec (HDPE) Corrugated Plastic Pipe Spec as:

ASTM General Construction		AASHTO Highway Construction
-ASTM-F-677 (3" - 24")	ASTM-F-2306 (12" - 60") ASTM-F-2648 (2" - 60")	AASHTO-M-252 (3" - 10") AASHTO-M-294 (12" - 60")

Corrosion Resistant Gravity Drain Pipe and Culverts

Waste Water

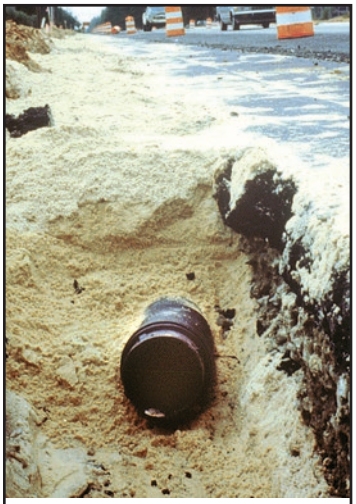
Storm Water

Adapts to other Materials

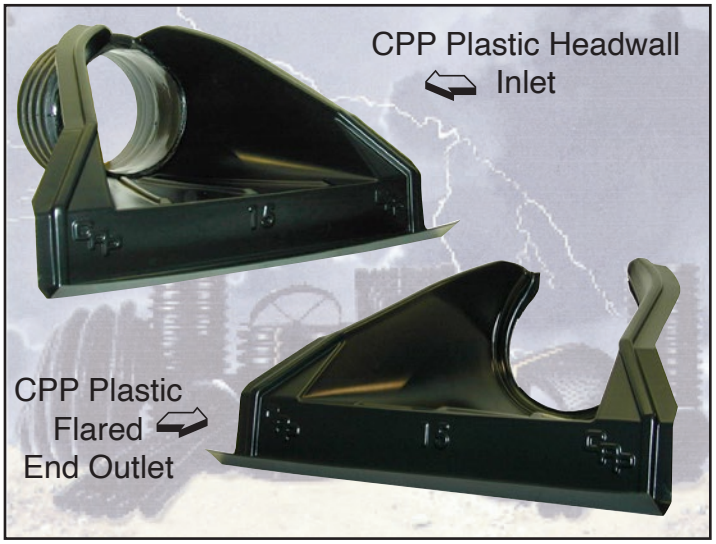
The Durability Product for Nutrient Rich Sites

Temporary and Permanent Highway Slope Drains

CPP Replaces Corroded Culverts



Highway Edge Drains



Endures Construction Abuse with Proper Compaction

To Spec (HDPE) Corrugated Plastic Pipe Spec as:

ASTM General Construction
- ASTM-F-677 (3” - 24”)
- ASTM-F-2306 (12” - 60”)
- ASTM-F2648 (2” - 6”)

AASHTO Highway Construction
- AASHTO-M-252 (3” - 10”)
- AASHTO-M-294 (12” - 60”)

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CPP
CORRUGATED PLASTIC PIPE

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