

Corrugated Metal Pipe Detention Design Guide

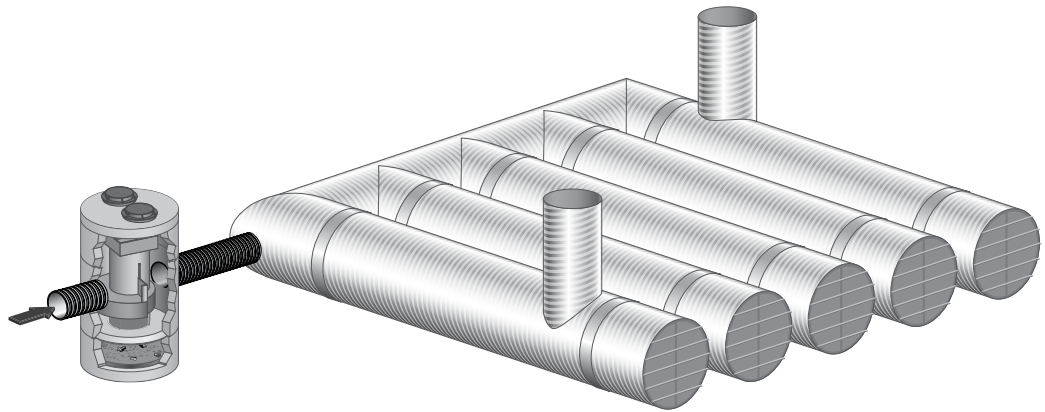


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CMP Detention System Design Tools

Design Your Own Detention System (DYODS®)

Contech's DYODS is an exclusive, online design tool that allows you to design your own detention or infiltration system. DYODS fully automates the layout process for stormwater detention and infiltration systems and produces CAD and PDF files that can be used for creating plans and specs, and for estimating total installed costs. Features of the new tool include:

- Optimizes design and layout for cost efficiency
- “Drag and drop” feature allow users to customize layout
- Design multiple systems per project and save for future use
- Provides instant access to customized, project specific drawings
- CAD/PDF files provided for use in creating plans and specs
- Guides the selection of CMP material and coatings



The DYODS tool is available at www.conteches.com/DYO.

Online Product Design Worksheet (PDW)

Our in-house team of engineers can support you through the entire permitting process. Just enter your information into the online form, and one of our in-house engineers will contact you with specific recommendations for your project.

The Detention Product Design Worksheet is available at www.conteches.com/detentionpdw

Engineering Services & Support

Contech has regional engineering offices and local stormwater consultants trained to provide regulatory guidance and permitting assistance, preliminary standard details and/or site specific final drawings and specifications, Low Impact Development design assistance, engineering calculations for hydraulics/hydrology, buoyancy, and stage-storage, installation support, maintenance support and more.

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Guidelines for Designing CMP Detention Systems

Please follow these guidelines when designing a custom fabricated CMP detention system.

- No riser or stubs on a weld.
- Minimum distance from riser or stub to a weld joint is 12".
- Riser minimum distance to end of pipe is 24".
- Stub minimum distance to end of pipe is 12".
- Spacing between pipe runs up to /incl 24" diameter pipe is 12", 24" to 72" diameter pipe is equal to half the diameter of pipe, => 72" Diameter pipe is 3 ft standard spacing.
- Minimum depth of earth cover is 1' above crown of pipe up 96" diameter pipe, 102" diameter pipe and over is 18" min. earth cover.
- Standardized length of pipe is 24' but can vary from one region to another. Speak to your local Contech representative for additional information.
- Minimum length of pipe needs to be 4 feet greater than the diameter of the pipe.
- Any system should be outside the building's foundation zone of influence and any system beneath a structure should be evaluated on an individual basis.

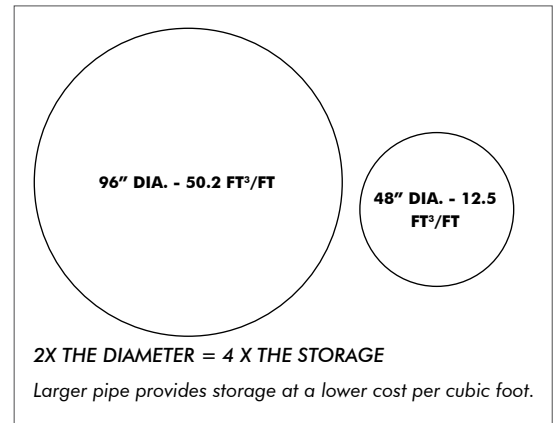
Cost-Effective Design and Layout

The three most important goals should be to shrink the footprint of the system by maximizing the storage volume within a given area, eliminate unnecessary welding and fabrication, and eliminate unnecessary structures.

Shrinking the Footprint

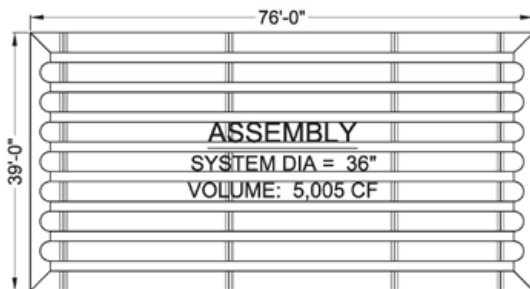
The goal of any CMP detention system should be to maximize the vertical space available to minimize the overall footprint, to reduce material, excavation, and backfill costs. To do this we recommend using the largest diameter pipe possible.

Increasing the depth of a CMP detention system allows for a smaller footprint while storing the same amount of water. For example, doubling the diameter of pipe yields four times as much storage volume per foot in the pipe. This provides significant cost savings per cubic foot of storage. Also, more vertical storage space means a smaller footprint equating to less excavation, less backfill and lower project costs.

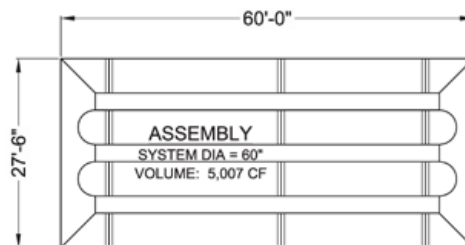


Consider the following example:

System 1 is made from 36" diameter pipe that provides 5,005 cubic feet of storage. System 2 is made from 60" diameter pipe that provides the same 5,005 cubic feet of storage. Both systems provide the same amount of storage, but System 2 is the most economical design as it reduces material costs, fabrication costs, excavation, and backfill costs. Having fewer runs of pipe will cut down on the number of welds and special fabrication requirements. Having fewer welds will also cut down on lead times. Lastly, System 2 has a footprint that is 1,300 square feet smaller than System 1, reducing excavation and backfill costs. The only instance, where System 2 may not be feasible, is when you do not have the available depth for the larger diameter pipe.



System 1

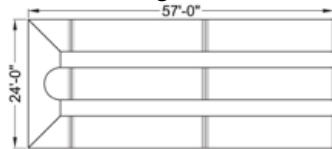


System 2

Eliminating Unnecessary Welds

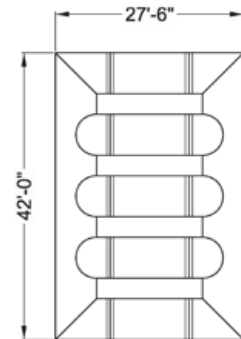
The rule of thumb is to use as much straight pipe as possible to reduce the number of tees and elbows in your design. Doing so will result in a more cost effective and efficient design, and will also reduce lead times. In the example below, both systems are designed with 72" diameter pipe and roughly the same storage volume. System 1 uses only two elbows and one tee and will be much more cost effective than System Two that uses four elbows and six tees.

Efficient Design



System 1

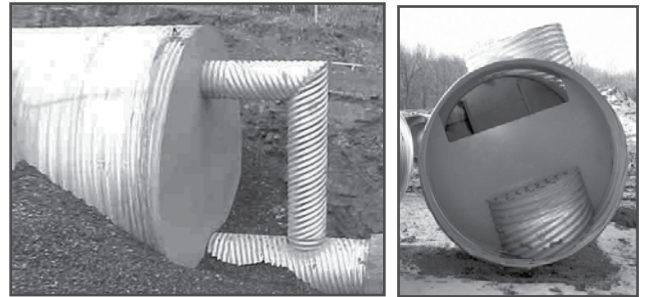
Inefficient Design



System 2

Eliminating Unnecessary Structures

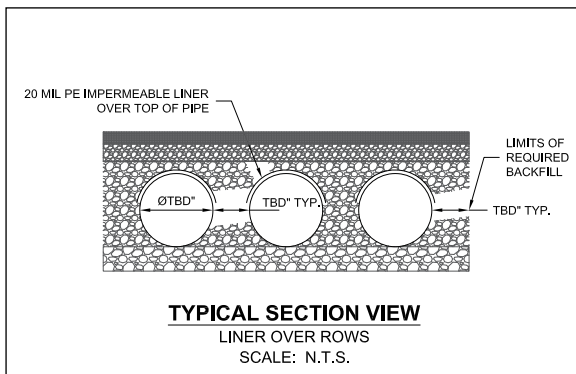
Costs can also be reduced by eliminating concrete structures such as catch basins and outlet control structures by incorporating them into the CMP system. For example, a riser can be added to a system in the low point of a parking lot with a grated inlet to eliminate a concrete catch basin. Internal weir plates and multiple external outlet stubs can often be used to eliminate a separate concrete outlet control structure downstream. Such designs may seem a bit unusual for an engineer that is used to designing with concrete structures. Contech's team of stormwater design engineers have experience in this and can assist with the routing designs of CMP detention systems.



CMP Detention Systems in Corrosive Environments

A site's resistivity may change over time when various types of salting agents are used, such as road salts for deicing purposes. If salting agents are used on or near the project site, a geomembrane barrier must be used with the system. The geomembrane liner is intended to help protect the system from the potential adverse effects that may result from the use of such salting agents including premature corrosion and reduced actual service life.

The project's Engineer of Record is to evaluate whether salting agents will be used on or near the project site, and use his/her best judgement to determine if any additional protective measures are required. Below is a typical detail showing the placement of a geomembrane barrier for projects where salting agents are used on or near the project site.



Standard Liner Over Rows

Detention Pipe Selection

Durability Design Guide for CMP Detention Products

Proper design of detention systems requires structural, hydraulic and durability considerations. While most designers are comfortable with structural and hydraulic design, the mechanics of evaluating abrasion, corrosion and water chemistry to perform a durability design are not found in most civil engineering handbooks.

The durability and service life of a CMP detention installation is directly related to the environmental conditions encountered at the site and the type of materials and coatings from which the system is fabricated. Two principle causes of early failure for CMP are corrosion and abrasion.

Service life can be affected by the corrosive action of the backfill in contact with the outside of a CMP detention or occasionally by the corrosive and abrasive action of the flow in the invert of the CMP detention. The design life analysis should include a check for both the water side and soil side environments to determine which is more critical— or which governs service life.

Metal loss in the invert of a CMP detention due to abrasive flows is not typical as the hydraulic dynamics are different as compared to a culvert application. An estimate for potential abrasion is required at each pipe location in order to determine the appropriate material and gage. Typical Detention applications are considered to have an Abrasion Level 1, or non-abrasive.

This manual is intended to guide specifiers through the mechanics of selecting appropriate materials to meet service life requirements. The information contained in the following pages is a composite of several national guidelines.



Procedure for Selection of the Appropriate System

The choice of material, gage and product type can be extremely important to service life. The following steps describe the procedure for selecting the appropriate CMP detention material and gage to meet a specific service life requirement.

Design Sequence:

1. Select pipe or structure based on hydraulic and clearance requirements.
2. Use Height of Cover tables for the chosen pipe or structure to determine the material gage required for the specific loading condition.
3. Use Table 2 to select the appropriate material for the site-specific environmental conditions. There may be some instances where more than one material is appropriate for the project environmental conditions. Generally speaking, the metal material types increase in price as you move from top down on Table 2. Please contact your local Contech Representative for pricing.
4. Use Table 3 to determine which abrasion level most accurately describes site conditions. The expected stream velocity and associated abrasion conditions should be based on a typical flow and not a 10 or 50-year design flood. Abrasion Level 1 is typically an accepted value for detention and infiltration applications.
5. Use Table 4 to determine whether the structural gage for the selected material is sufficient for the design service life. If the structural gage is greater than or equal to the gage required for a particular abrasion condition and service life, use the structural gage. Conversely, if the structural gage is less than the gage required for a particular abrasion condition and service life, use the gage required by Table 4.

Note: Corrosive environments, such as seawater and road/de-icing salt infiltration, and other environments with pH and resistivity outside of the recommended range may cause premature corrosion and reduce actual service life. See page 19 for additional information.

Table 1 - AASHTO Reference Specifications

Pipe & Pipe Arch	Material Type	Material	Pipe	Design*	Installation*	
	CMP (1/2" or 1" deep corrugations)					
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26	
	Asphalt Coated	M190	M36	Section 12	Section 26	
	Asphalt Coated and Paved Invert	M190	M36	Section 12	Section 26	
	Aluminized Type 2	M274	M36	Section 12	Section 26	
	Polymer Coated	M246	M36 & M245	Section 12	Section 26	
	Aluminum Alloy	M197	M196	Section 12	Section 26	
	ULTRA FLO® (3/4" x 3/4" x 7-1/2" corrugation)					
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26	
Aluminized Type 2	M274	M36	Section 12	Section 26		
Polymer Coated	M246	M36 & M245	Section 12	Section 26		
Aluminum Alloy	M197	M196	Section 12	Section 26		
Smooth Cor™						
Polymer Coated	M246	M36 & M245	Section 12	Section 26		

* AASHTO LRFD Bridge Design Specification and AASHTO Standard Specification for Highway Bridges

Table 2 — Recommended Environments

Material Type	Soil* and Water pH											Resistivity (ohm-cm)	
	3	4	5	6	7	8	9	10	11	12	Minimum	Maximum	
Galvanized Steel*											2,000	10,000	
Aluminized Steel Type 2											1,500	N/A	
Polymer Coated											250	N/A	
Aluminum Alloy											500	N/A	

*Appropriate pH range for Galvanized Steel is 6.0 to 10

Table 3 — FHWA Abrasion Guidelines

Abrasion Level	Abrasion Condition	Bed Load	Flow Velocity (fps)
1*	Non-Abrasive	None	Minimal
2	Low Abrasion	Minor	< 5
3	Moderate Abrasion	Moderate	5 - 15
4	Severe Abrasion	Heavy	> 15

"Interim Direct Guidelines on CMP Drainage Alternative Selection." FHWA, 2005.

* Typical abrasion level for Detention and Infiltration applications is level 1.

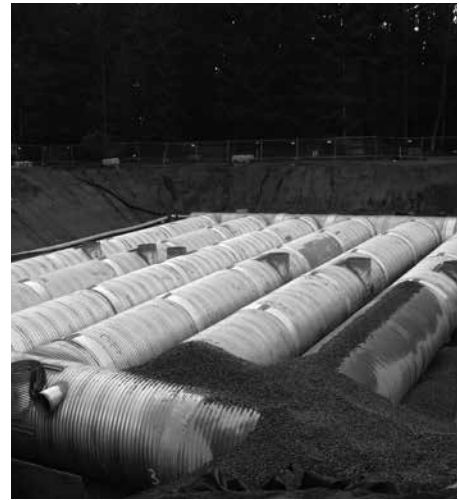


Table 4 – CMP Detention & Infiltration Typical Gage Recommendations

Design Service Life ¹ Estimates	25 Years	50 Years	75 Years	100 Years
Abrasion Level 1 & 2				
Galvanized (2 oz.) ²	16	12	10	8 ⁵
Aluminized Type 2 ³	16	16	16	14 ⁶
Polymer Coated ⁴	16	16	16 ⁷	16 ⁸
Aluminum Alloy	16	16	16	16

"Interim Direct Guidelines on CMP Drainage Alternative Selection." FHWA, 2005.

- All service life guidance is based on use in certain recommended environments only.
- The National Corrugated Steel Pipe Association (NCSPA) provides service life guidance for galvanized materials, with service life guidance up to 97 years for 8 GA galvanized.
- Aluminized Type 2 is the typical coating for most detention and infiltration applications. The NCSPA service life guidance of 75+ years for ALT2 in recommended environments, for pH 5-9 and resistivity > 1,500 ohm-cm.
- The NCSPA provides service life guidance for polymer coated materials. Service life guidance of up to 75 years for polymer coated materials is based on a pH range of 4-9 and resistivity greater than 750 ohm-cm and of up to 100 years for polymer coated is based on a pH range of 5-9 and resistivity greater than 1,500 ohm-cm.
- Design service life for 8 GA galvanized is 97 years.
- NCSPA states that 14 GA ALT2 can achieve a 100 year service life when the environmental conditions have a pH of 5 to 9 and a resistivity greater than 1,500 ohm-cm.
- 75 year service life for polymer-coated is based on a pH range of 4-9 and resistivity greater than 750 ohm-cm.
- 100 year service life for polymer-coated is based on a pH range of 5-9 and resistivity greater than 1,500 ohm-cm.

CMP for Subsurface Infiltration

- CMP infiltration systems can be designed to meet HS 20 or greater load requirements with proper depths of cover.
- Protective pipe coatings such as Aluminized Type 2 (ALT2), Galvanized, and Polymer-Coated are matched to the pH and resistivity of the surrounding soil. See table 3 for additional information.
- CMP infiltration systems need to be surrounded by clean crushed stone to provide increased capacity utilizing storage in the void space. The system is then wrapped with fabric on the sides and top. The fabric is primarily used to keep native soils from filling stone voids and reducing long term storage capacity.

Storage Volumes for Corrugated Steel Pipe

Round Pipe - Hydraulic Storage per Linear Foot	
Diameter (Inches)	Hydraulic Storage (CF per FT)
12	0.8
15	1.2
18	1.8
21	2.4
24	3.1
30	4.9
36	7.1
42	9.6
48	12.6
54	15.9
60	19.6
66	23.8
72	28.3
78	33.2
84	38.5
90	44.2
96	50.3
102	56.7
108	63.6
114	70.9
120	78.5
126	86.6
132	95.0
138	103.9
144	113.1

Pipe Arch - Hydraulic Storage per Linear Foot		
2 2/3" x 1/2" Corrugated Steel Pipe		
Diameter (Inches)	Pipe Arch Equivalent Size (Inches)	Hydraulic Storage (CF per FT)
15	17 x 13	1.1
18	21 x 15	1.6
21	24 x 18	2.2
24	28 x 20	2.4
30	35 x 24	4.5
36	42 x 29	6.5
42	49 x 33	8.9
48	57 x 38	11.6
54	64 x 43	14.7
60	71 x 47	18.1
66	77 x 52	21.9
72	83 x 57	26.0

Pipe Arch - Hydraulic Storage per Linear Foot		
3" x 1" or 5" x 1" Corrugated Steel Pipe		
Diameter (Inches)	Pipe Arch Equivalent Size (Inches)	Hydraulic Storage (CF per FT)
54	60 x 46	15.6
60	66 x 51	19.3
66	73 x 55	23.2
72	81 x 59	27.4
78	87 x 63	32.1
84	95 x 67	37.0
90	103 x 71	42.4
96	112 x 75	48.0
102	117 x 79	54.2
108	128 x 83	60.5
114	137 x 87	67.4
120	142 x 91	74.5



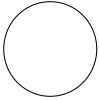
Height of Cover and Weights Tables for HEL-COR® Corrugated Steel Pipe (CSP)

Heights of Cover Notes:

- These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Stormwater Consultant for Height of Cover tables on riveted pipe.
- These values, where applicable, were calculated using a load factor of $K=0.86$ as adopted in the NCSPA CSP Design Manual, 2008.
- The span and rise shown in these tables are nominal. Typically the actual rise that forms is greater than the specified nominal. This actual rise is within the tolerances as allowed by the AASHTO & ASTM specifications. The minimum covers shown are more conservative than required by the AASHTO and ASTM specifications to account for this anticipated increase in rise. Less cover height may be tolerated depending upon actual rise of supplied pipe arch.
- H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- 0.052" is 18 gage.
0.064" is 16 gage.
0.079" is 14 gage.
0.109" is 12 gage.
0.138" is 10 gage.
0.168" is 8 gage.
- For construction and firetruck loads, see Page 18.
- 1-1/2" x 1/4" corrugation. H 20, H 25 and E 80 loading.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.


Heights of Cover Limits – 2 2/3" x 1/2" HEL-COR CSP

H 20 and H 25 Live Loads



Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet					
		Specified Thickness, Inches					
		0.052	0.064	0.079	0.109	0.138	0.168
6 ^ø	12	388	486				
8 ^ø	12	291	365				
10 ^ø	12	233	392				
12	12	197	248	310			
15	12	158	198	248			
18	12	131	165	206			
21	12	113	141	177	248		
24	12	98	124	155	217		
30	12		99	124	173		
36	12		83	103	145	186	
42	12		71	88	124	159	195
48	12		62	77	108	139	171
54	12			67	94	122	150
60	12				80	104	128
66	12				68	88	109
72	12					75	93
78	12						79
84	12						66

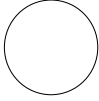
H 20 and H 25 Live Loads, Pipe-Arch



Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
15	17 x 13	0.064	12	16
18	21 x 15	0.064	12	15
21	24 x 18	0.064	12	15
24	28 x 20	0.064	12	15
30	35 x 24	0.064	12	15
36	42 x 29	0.064	12	15
42	49 x 33	0.064*	12	15
48	57 x 38	0.064*	12	15
54	64 x 43	0.079*	12	15
60	71 x 47	0.109*	12	15
66	77 x 52	0.109*	12	15
72	83 x 57	0.138*	12	15


Heights of Cover Limits – 5" x 1" or 3" x 1" HEL-COR CSP

H 20 and H 25 Live Loads



Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet				
		Specified Thickness, Inches				
		0.064	0.079	0.109	0.138	0.168
54	12	56	70	98	127	155
60	12	50	63	88	114	139
66	12	46	57	80	103	127
72	12	42	52	74	95	116
78	12	39	48	68	87	107
84	12	36	45	63	81	99
90	12	33	42	59	76	93
96	12	31	39	55	71	87
102	18	29	37	52	67	82
108	18		35	49	63	77
114	18		32	45	58	72
120	18		30	42	54	66
126	18			39	50	61
132	18			36	46	58
138	18			33	43	53
144	18				39	49

H 20 and H 25 Live Loads, Pipe-Arch



Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
72	81 x 59	0.109	18	21
78	87 x 63	0.109	18	20
84	95 x 67	0.109	18	20
90	103 x 71	0.109	18	20
96	112 x 75	0.109	21	20
102	117 x 79	0.109	21	19
108	128 x 83	0.109	24	19
114	137 x 87	0.109	24	19
120	142 x 91	0.138	24	19

Larger sizes are available in some areas of the United States. Check with your local Contech representative. Some minimum heights of cover for pipe-arches have been increased to take into account allowable "plus" tolerances on the manufactured rise.

Maximum cover heights shown are for 5" x 1".

To obtain maximum cover for 3" x 1", increase these values by 12%.

Approximate Weight – Pounds/Foot HEL-COR® CSP

(Estimated Average Weights—Not for Specification Use)

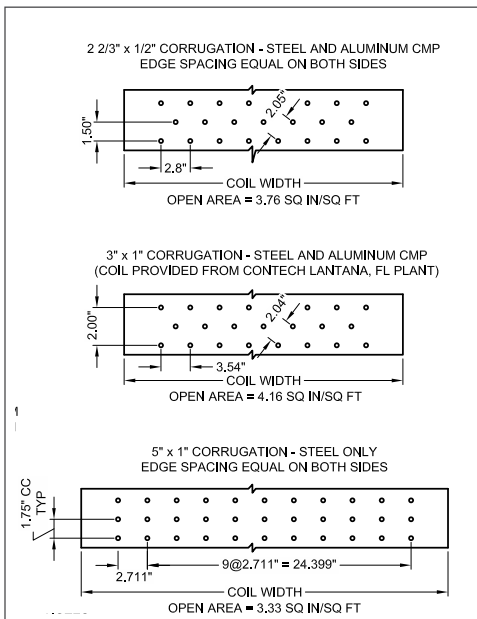
2 2/3" x 1/2" HEL-COR® CSP						
Inside Diameter, Inches	Weight (Pounds/Feet)					
	Specified Thickness (Gage)					
	0.052	0.064	0.079	0.109	0.138	0.168
	18	16	14	12	10	8
12	8	10	12			
15	10	12	15			
18	12	15	18			
21	14	17	21	29		
24	15	19	24	33		
30		24	30	41		
36		29	36	49	62	
42		34	42	57	72	88
48		38	48	65	82	100
54			54	73	92	112
60				81	103	124
66				89	113	137
72					123	149
78						161
84						173

3" x 1" HEL-COR® CSP						
Inside Diameter, Inches	Weight (Pounds/Feet)					
	Specified Thickness (Gage)					
	0.052	0.064	0.079	0.109	0.138	0.168
	18	16	14	12	10	8
54		50	61	83	106	129
60		55	67	92	118	143
66		60	74	101	129	157
72		66	81	110	140	171
78		71	87	119	152	185
84		77	94	128	164	199
90		82	100	137	175	213
96		87	107	147	188	228
102		93	114	155	198	241
108			120	165	211	256
114			127	174	222	271
120			134	183	234	284
126				195	247	299
132				204	259	259
138				213	270	328
144					282	344

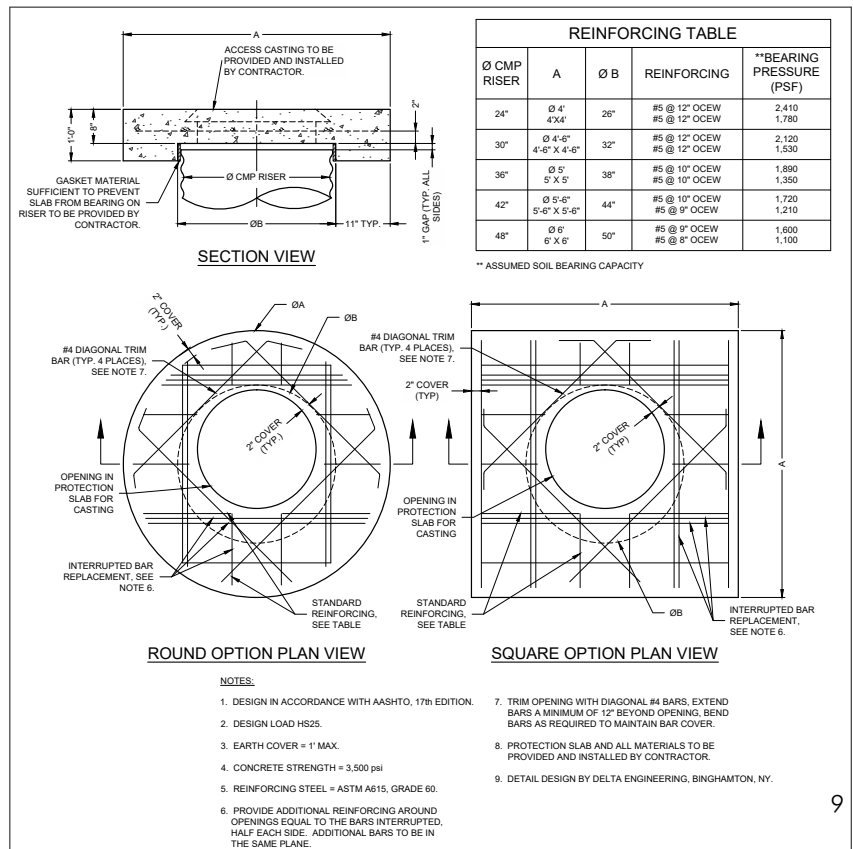
Notes:

- Weights shown apply to galvanized and aluminized type 2 (ALT2) CSP only. Weights for polymer coated CSP are 1% to 4% higher, varying by gage.
- Please contact your Contech Stormwater Consultant.
- Weights listed in the 3" x 1" or 5" x 1" table are for 3" x 1" pipe. Weights for 5" x 1" are approximately 12% less than those used in this table, for metallic coated pipe.

CMP Perforation Details



Manhole Cap Detail



Height of Cover and Weights Tables - CORLIX® Corrugated Aluminum Pipe (CAP)

Heights of Cover Limits – 2 2/3" x 1/2" CORLIX CAP



HL 93 Live Load

Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet ⁽²⁾ Specified Thickness (Gage)					
		18	16	14	12	10	8 ⁽⁵⁾
6 ⁽⁴⁾	12	197	247				
8 ⁽⁴⁾	12	147	185				
10 ⁽⁴⁾	12	119	148				
12	12		125	157			
15	12		100	125			
18	12		83	104			
21	12		71	89			
24	12		62	78	109		
27	12			69	97		
30	12			62	87		
36	12			51	73	94	
42	12				62	80	
48	12				54	70	85
54	15				48	62	76
60	15					52	64
66	18						52
72	18						43



HL 93 Live Load, Pipe-Arch

Round Pipe Dia. (Inches)	Size, Inches Span x Rise	Minimum Gage	Minimum Cover ⁽³⁾ (Inches)	Maximum Cover, (Ft.) Aluminum Pipe-Arch ⁽²⁾ 2 Tons/Ft. ² for Corner Bearing Pressures
15	17 x 13	16	12	13
18	21 x 15	16	12	12
21	24 x 18	16	12	12
24	28 x 20	14	12	12
30	35 x 24	14	12	12
36	42 x 29	12	12	12
42	49 x 33	12	15	12
48	57 x 38	10	15	12
54	64 x 43	10	18	12
60	71 x 47	8 ⁽⁵⁾	18	12

Notes:

1. Height of cover is measured to top of rigid pavement or to bottom of flexible pavement.
2. Maximum cover meets AASHTO LRFD design criteria.
3. Minimum cover meets AASHTO and ASTM B 790 design criteria.
4. 1 1/2" x 1/4" corrugation.
5. 8-gage pipe has limited availability.
6. For construction loads, see page 18.

Approximate Weight – Pounds/Foot

CORLIX® CAP

(Estimated Average Weights—Not for Specification Use)

Diameter or Span, Inches	2 2/3" x 1/2" CORLIX® CAP					
	Weight (Pounds/Feet) Specified Thickness (Gage)					
	0.048 18	0.060 16	0.075 14	0.105 12	0.135 10	0.164 8 ⁽³⁾
6 ⁽⁴⁾	1.3	1.6				
8 ⁽⁴⁾	1.7	2.1				
10 ⁽⁴⁾	2.1	2.6				
12		3.2	4			
15		4	4.9			
18		4.8	5.9			
21		5.6	6.9			
24		6.3	7.9	10.8		
27			8.8	12.2		
30			9.8	13.5		
36			11.8	16.3	20.7	
42				19	24.2	
48				21.7	27.6	33.5
54				24.4	31.1	37.7
60					34.6	41.9
66						46
72						50.1

Diameter or Span, Inches	3" x 1" CORLIX® CAP				
	Weight (Pounds/Feet) Specified Thickness (Gage)				
	0.060 16	0.075 14	0.105 12	0.135 10	0.164 8 ⁽³⁾
30	9.3	11.5	15.8	20.2	
36	11.1	13.7	18.9	24.1	
42	12.9	16	22	28	
48	14.7	18.2	25.1	32	38.8
54	16.5	20.5	28.2	35.9	43.6
60	18.3	22.7	31.3	40	48.3
66	20.2	24.9	34.3	43.7	53
72	22	27.1	37.4	47.6	57.8
78		29.3	40.4	51.5	62.5
84			43.5	55.4	67.2
90			46.6	59.3	71.9
96			49.6	63.2	76.7
102				66.6	80.8
108				71	86.1
114					90.9
120					95.6

Notes:

1. Helical lockseam pipe only. Annular riveted pipe weights will be higher.
2. 1 1/2" x 1/4" Corrugation.
3. 8-gage pipe has limited availability.

Pretreatment Options

Regardless of infiltration material type and configuration, one of the most important components to consider is pretreatment. A pretreatment device prolongs the life of the infiltration system by removing debris and sediment that can collect on the invert and within the stone backfill voids. Pretreatment will maintain the efficiency of an infiltration system as well as extend the life cycle, therefore preventing a premature replacement. Pretreatment also offers these additional benefits:

- Pretreatment creates a single collection point which is easier to clean and maintain compared to the infiltration system alone.
- Cost savings due to the extended service life of the system.
- Removing trash and debris protects downstream outlet control structures from clogging.

Contech offers a number of pretreatment options, all of which will extend the life of subsurface infiltration systems and improve water quality. The type of system chosen will depend on a number of factors including footprint, soil conditions, local regulations, and the desired level of pretreatment.

Hydrodynamic Separation

Hydrodynamic Separation (HDS) provides a basic level of pretreatment by capturing and retaining trash and debris, sediment, and oil from stormwater runoff.

Cascade Separator™

The Cascade Separator™ is the latest innovation in hydrodynamic separation from Contech. The Cascade uses advanced sediment capture technology to provide the highest sediment removal efficiency of any Contech HDS product. Cascade also captures trash and hydrocarbons.

CDS®

The CDS® uses both swirl concentration and a nonblocking screen to capture and retain 100% of floatables and neutrally buoyant debris 4.7mm or larger.

Vortechs®

Vortechs combines swirl concentration and flow controls into a shallow treatment unit that traps and retains trash, debris, sediment, and hydrocarbons from stormwater runoff. Vortechs removes sediment down to 50 microns and is the ideal solution for projects that require a shallow treatment device due to groundwater, utility, or bedrock constraints.

Filtration

Filtration provides a higher level of pretreatment and improved water quality by removing trash and debris, oil, fine solids, and dissolved pollutants such as metals, hydrocarbons, and nutrients.

Filterra® Bioretention System

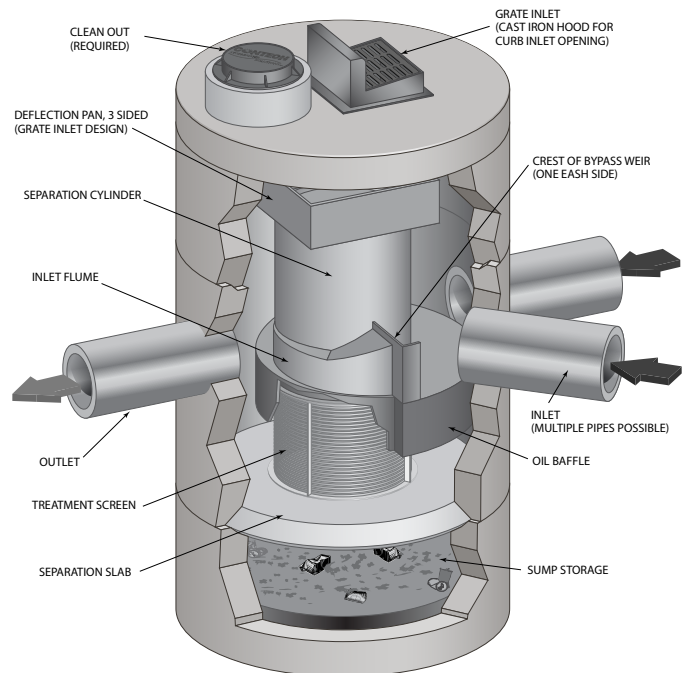
Filterra is an engineered bioretention system that has been optimized for high volume/flow treatment and high pollutant removal.

The Stormwater Management StormFilter®

The StormFilter system is comprised of a structure that houses rechargeable, media-filled cartridges. The media can be customized to target site-specific pollutants.

Jellyfish® Filter

The Jellyfish filter uses membrane filtration in a compact footprint to remove a high level and a wide variety of stormwater pollutants such as fine particulates, oil, trash and debris, metals, and nutrients.



CDS® Hydrodynamic Separator

Custom Fabrication and Fittings

One of the benefits of CMP detention systems is its flexibility. With the addition of elbows, tees, stubs, and other components, CMP detention systems can be configured to meet sight specific constraints.

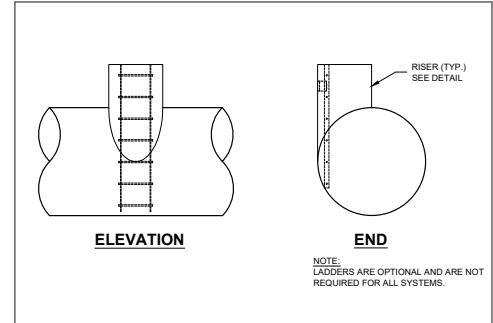
Benefits of Custom Fabrication

- More efficiently match site constraints
- System components are easy to install
- Provide maintenance ready structures - easily accessible
- Easily control influent and effluent
- Eliminate concrete structures such as junction boxes

CMP is also versatile enough for use for the entire stormwater system, including:

- Slotted drain pipe
- Storm sewer pipe
- Manholes / Inlet structures

Typical Riser Detail



One benefit to CMP detention systems is that we can integrate the manhole risers so you don't have to have an additional concrete junction box which can add cost to the project. Vertical risers can be used as manholes or inlets...or both, and ladders can be added so the opening can be used for access. We typically locate the manhole on the side of the pipe so that the ladder can be extend down the wall of the pipe to the invert.

Sample Proposal Drawing

The drawing shows a long assembly of CMP pipes with risers and ladders. The total length is 239' 6" and the height is 47' 0".

ASSEMBLY
SCALE: 1" = 20'

PROJECT SUMMARY

<p>CALCULATION DETAILS</p> <ul style="list-style-type: none"> • LENGTH PER BARREL = 235 FT • LENGTH PER HEADER = 47 FT • LOADING = H20 & H25 • APPROX. CMP FOOTAGE = 1,692 FT 	<p>STORAGE SUMMARY</p> <ul style="list-style-type: none"> • STORAGE VOLUME REQUIRED 36,500 CF • PIPE STORAGE = 26,910 CF • STRUCTURAL BACKFILL STORAGE = 9,677 CF • TOTAL STORAGE PROVIDED = 36,587 CF 	<p>PIPE DETAILS</p> <ul style="list-style-type: none"> • DIAMETER = 54 IN • CORRUGATION = 5" X 1" OR 3" X 1" • GAGE = 16 • COATING = ALUMINIZED STEEL • TYPE 2 (ALT2) • WALL TYPE = PERFORATED • BARREL SPACING = 31 IN 	<p>BACKFILL DETAILS</p> <ul style="list-style-type: none"> • WIDTH AT ENDS = 12 IN • ABOVE PIPE = 0 IN • WIDTH AT SIDES = 12 IN • BELOW PIPE = 6 IN
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NOTES:

- ALL RISER AND STUB DIMENSIONS ARE TO CENTERLINE. ALL ELEVATIONS, DIMENSIONS AND LOCATIONS OF RISERS AND INLETS SHALL BE VERIFIED BY THE ENGINEER OR RECORD PRIOR TO RELEASING FOR FABRICATION.
- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A996.
- ALL RISERS AND STUBS ARE 2 1/2" X 1/2" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUBS FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN. QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.

	 CONTECH CONSTRUCTION SOLUTIONS LLC www.contechES.com 9205 Centre Pointe Dr., Suite 400, West Chester, OH 45399 800-338-1122 513-645-7000 513-645-7993 FAX	 CONTECH CMP DETENTION SYSTEMS CONTECH DYODS DRAWING	DYODS - 1471-1-0 PROJECT NAME: Edina Transportation Facility Edina, MN 55426 DESCRIPTION: UGS#1	<table border="1"> <tr> <td>PROJECT No.</td> <td>1471-1</td> <td>REV. No.</td> <td>0</td> <td>DATE</td> <td>9/6/2016</td> </tr> <tr> <td>DRAWN</td> <td>DYODS</td> <td>CHECKED</td> <td></td> <td>APPROVED</td> <td></td> </tr> <tr> <td>SHEET No.</td> <td colspan="5">D1</td> </tr> </table>	PROJECT No.	1471-1	REV. No.	0	DATE	9/6/2016	DRAWN	DYODS	CHECKED		APPROVED		SHEET No.	D1				
PROJECT No.	1471-1	REV. No.	0	DATE	9/6/2016																	
DRAWN	DYODS	CHECKED		APPROVED																		
SHEET No.	D1																					

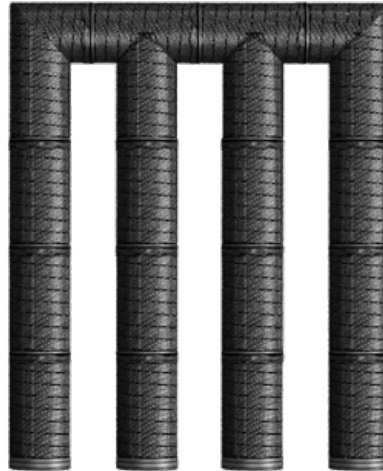
Note: Fittings will need to be structurally checked for reinforcements.

CMP Detention System Bedding and Backfill

Please follow the guidelines below regarding pipe bedding and backfill.

1. Minimum trench width must allow room for proper compaction of haunch materials under pipe. min. width = $(1.5 \times \text{diameter}) + 12''$ (follow AASHTO Section 12 & 26).
 - a. The minimum embankment width is 3 pipe diameters.
2. The foundation shall be well consolidated & stable.
3. The bedding material shall be a relatively loose material that is roughly shaped to fit the bottom of the pipe, 4" to 6" in depth.
4. Bedding material shall be a relatively loose material that is roughly shaped to fit the bottom of the pipe, and a minimum of twice the corrugation depth in thickness, with the maximum particle size of one-half of the corrugation depth (AASHTO Section 26.3.8.1, 26.5.3).
 - a. Haunch zone material shall be hand shoveled or shovel sliced into place to allow for proper compaction.
5. H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement. Minimum cover is 12 inches for diameters up to and including 96", 18 inches for diameters ranging from 102" and greater.
6. Final backfill material selection and compaction requirements per the project plans, specifications, or engineer of record.
7. Geotextile shall be used as required to prevent soil migration.
8. Final backfill material selection and compaction requirements shall follow the project plans and specifications per the engineer of record (26.5.4.1).

Single Manifold System



No Manifold System



CMP Detention System Installation

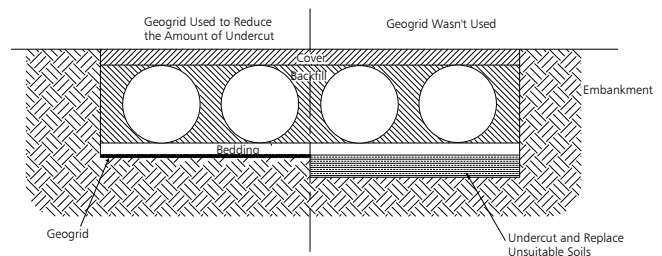
Overview

Proper installation of a flexible underground detention system will ensure long-term performance. The configuration of these systems often requires special construction practices that differ from conventional flexible pipe construction. Contech Engineered Solutions strongly suggests scheduling a pre-construction meeting with your local Sales Engineer to determine if additional measures, not covered in this guide, are appropriate for your site.

Foundation

Construct a foundation that can support the design loading applied by the pipe and adjacent backfill weight as well as maintain its integrity during construction.

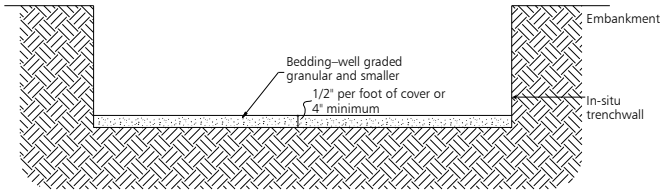
If soft or unsuitable soils are encountered, remove the poor soils down to a suitable depth and then build up to the appropriate elevation with a competent backfill material. The structural fill material gradation should not allow the migration of fines, which can cause settlement of the detention system or pavement above. If the structural fill material is not compatible with the underlying soils an engineering fabric should be used as a separator. In some cases, using a stiff reinforcing geogrid reduces over excavation and replacement fill quantities.



Grade the foundation subgrade to a uniform or slightly sloping grade. If the subgrade is clay or relatively non-porous and the construction sequence will last for an extended period of time, it is best to slope the grade to one end of the system. This will allow excess water to drain quickly, preventing saturation of the subgrade.

Bedding

A 4 to 6-inch thick, well-graded, granular material is the preferred pipe bedding. If construction equipment will operate for an extended period of time on the bedding, use either an engineering fabric or a stiff geogrid to ensure the base material maintains its integrity.

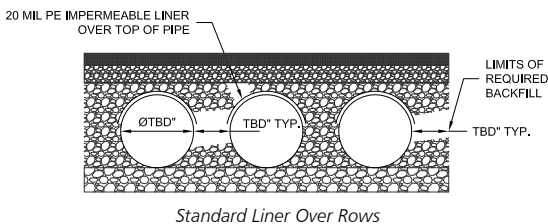


Using a relatively loose material, grade the base to a smooth, uniform grade to allow for the proper placement of the pipe. Using an open-graded bedding material is acceptable; however, an engineering fabric separator is required between the base and the subgrade.

Geomembrane Barrier

A site’s resistivity may change over time when various types of salting agents are used, such as road salts for deicing purposes. If salting agents are used on or near the project site, a geomembrane barrier must be used with the system. The geomembrane liner is intended to help protect the system from the potential adverse effects that may result from the use of such salting agents including premature corrosion and reduced actual service life.

The project’s Engineer of Record is to evaluate whether salting agents will be used on or near the project site, and use his/her best judgement to determine if any additional protective measures are required. Below is a typical detail showing the placement of a geomembrane barrier for projects where salting agents are used on or near the project site.

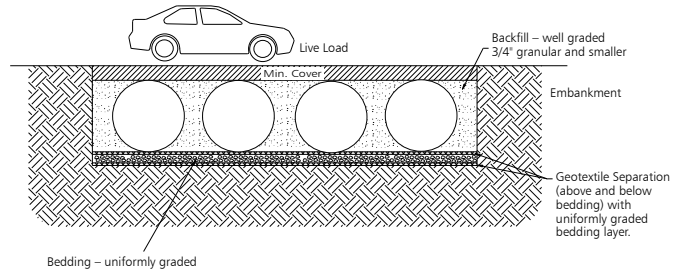


In-Situ Trench Wall

If excavation is required, the trench wall needs to be capable of supporting the load that the pipe sheds as the system is loaded. If soils are not capable of supporting these loads, the pipe can deflect. Perform a simple soil pressure check using the applied loads to determine the limits of excavation beyond the spring line of the outer most pipes. In most cases the requirements for a safe work environment and proper backfill placement and compaction take care of this concern.

Backfill Material

Typically, the best backfill material is an angular, well-graded, granular fill meeting the requirements of AASHTO A-1, A-2 or A-3. In some cases, it may be desirable to use a uniformly graded material for the first 18- to 24-inches. This type of material is easier to place under the haunches of the pipe and requires little compactive effort. Depending on the bedding material, a separation geotextile might be required above and below these initial lifts.

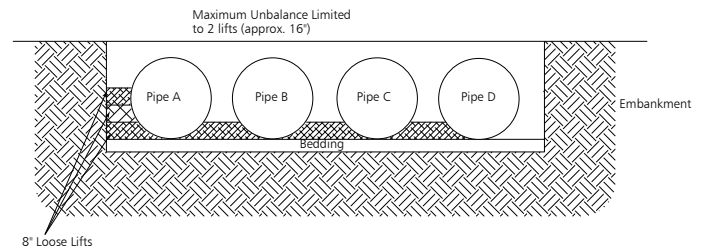


Open-graded fill is typically not used beyond the initial 18- to 24-inches because this type of fill often does not provide adequate confining restraint to the pipes. If a uniformly graded material (particles all one size) is used, install a geotextile separation fabric to prevent the migration of fines into the backfill.

Backfill using controlled low-strength material (CLSM or “flowable fill”) when the spacing between the pipes will not allow for placement and adequate compaction of the backfill. Work closely with the local Contech Stormwater Consultant regarding the special installation techniques required when using CLSM.

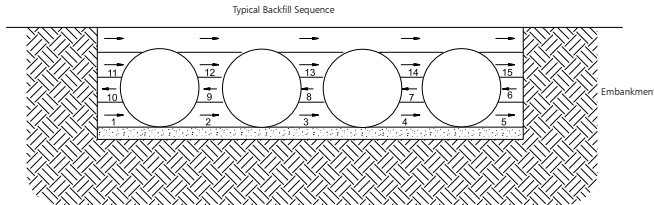
Backfill Placement

Place backfill in 8-inch loose lifts and compact to 90% AASHTO T99 standard proctor density. Material shall be worked into the pipe haunches by means of shovel-slicing, rodding, air tamper, vibratory rod, or other effective methods. If AASHTO T99 procedures are determined infeasible by the geotechnical engineer of record, compaction is considered adequate when no further yielding of the material is observed under the compactor, or under foot, and the geotechnical engineer of record (or representative thereof) is satisfied with the level of compaction.

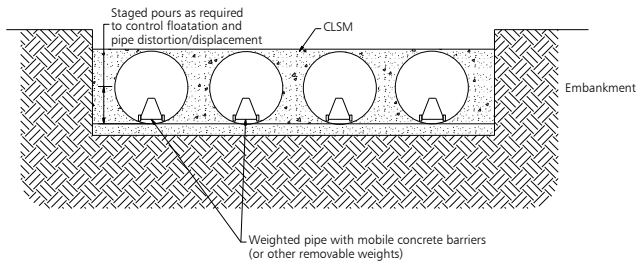


For large systems, conveyor systems, backhoes with long reaches or draglines with stone buckets may be used to place backfill.

Once minimum cover for construction loading across the entire width of the system is reached, advance the equipment to the end of the recently placed fill, and begin the sequence again until the system is completely backfilled. This type of construction sequence provides room for stockpiled backfill directly behind the backhoe, as well as the movement of construction traffic. Material stockpiles on top of the backfilled detention system should be limited to 8- to 10-foot high and must provide balanced loading across all barrels. To determine the proper cover over the pipes to allow the movement of construction equipment see Table 1, or contact your local Contech Stormwater Consultant.



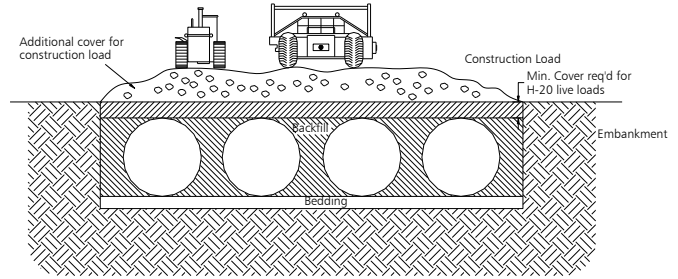
When flowable fill is used, you must prevent pipe floatation. Typically, small lifts are placed between the pipes and then allowed to set-up prior to the placement of the next lift. The allowable thickness of the CLSM lift is a function of a proper balance between the uplift force of the CLSM, the opposing weight of the pipe, and the effect of other restraining measures. The pipe can carry limited fluid pressure without pipe distortion or displacement, which also affects the CLSM lift thickness. Your local Contech Stormwater Consultant can help determine the proper lift thickness.



Construction Loading

Typically, the minimum cover specified for a project assumes H-20 live load. Because construction loads often exceed design live loads, increased temporary minimum cover requirements are necessary. Since construction equipment varies from job to job, it is best to address equipment specific minimum cover requirements with your local Contech Stormwater Consultant during your pre-construction meeting.

HEL-COR® CSP Minimum Height of Cover Requirements for Heavy Off-Road Construction Equipment				
Pipe Span, Inches	Minimum Cover, Inches for Indicated Axle Loads (kips)			
	18-50	50-75	75-110	110-150
12 - 42	24	30	36	36
48-72	36	36	42	48
78-120	36	42	48	48
126 - 144	42	48	54	54



Firetruck Loading

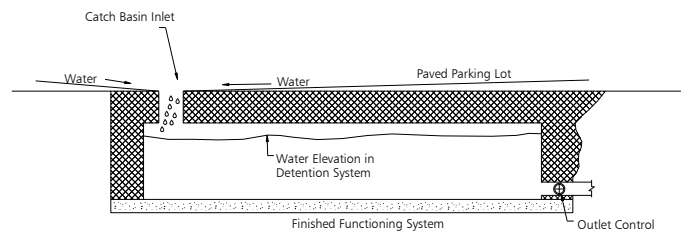
Please use the table below for general guidance.

HEL-COR® CSP Minimum Height of Cover Requirements for Firetruck Loading ¹					
Pipe Span, Inches	Corrugation Profile, Inches	Minimum Cover, Inches for Firetruck Outrigger Load (64 kips) ^{2,3}			
		16 GA 0.064	14 GA 0.079	12 GA 0.109	10 GA 0.138
12 - 36	2 2/3 x 1/2	12	12	12	12
42 - 48	2 2/3 x 1/2	18	18	18	18
54 - 60	3 x 1 or 5 x 1	24	18		
72	3 x 1 or 5 x 1	30	24		
78 - 120	3 x 1 or 5 x 1		36	30	
126 - 144	3 x 1 or 5 x 1			42	36

1. Minimum cover may vary depending on local conditions. The contractor must provide additional cover required to avoid damage to the pipe. **Minimum cover is measured from the top of the pipe to the top of the maintained construction roadway surface.**
2. Table is based on a typical 85,000 lb GVW firetruck with an outrigger load of 64,000 lbs. The 64,000 lb outrigger force is applied over a surface area of about 850.6 in². The dimensions of the outrigger square pad are 25-7/8" x 32-7/8".
3. The outrigger load will be the heaviest load applied from the firetruck.

Additional Considerations

Because most systems are constructed below-grade, rainfall can rapidly fill the excavation; potentially causing floatation and movement of the previously placed pipes. To help mitigate potential problems, it is best to start the installation at the downstream end with the outlet already constructed to allow a route for the water to escape. Temporary diversion measures may be required for high flows due to the restricted nature of the outlet pipe.





Contech Engineered Solutions LLC is a leading provider of site solution products and services for the civil engineering industry. Contech's product portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control, soil stabilization and wastewater products.

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

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