Industry Standards for Underground Storm Water Chamber Systems

Mark A. Scholle, PE

Regional Engineer / Products Manager

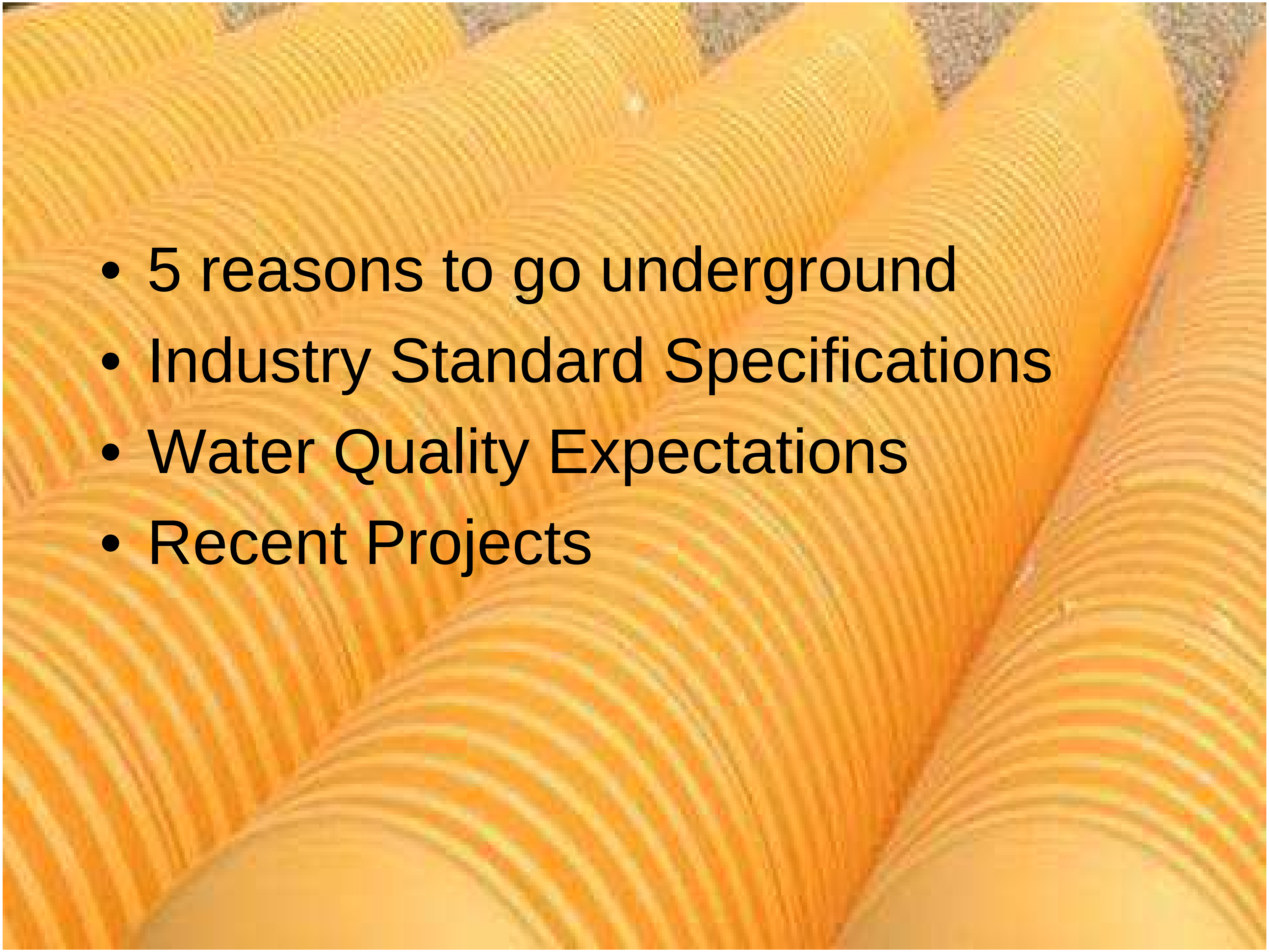
MN, WI, ND

MECA

StormTech®

Detention • Retention • Water Quality

Division of ADS



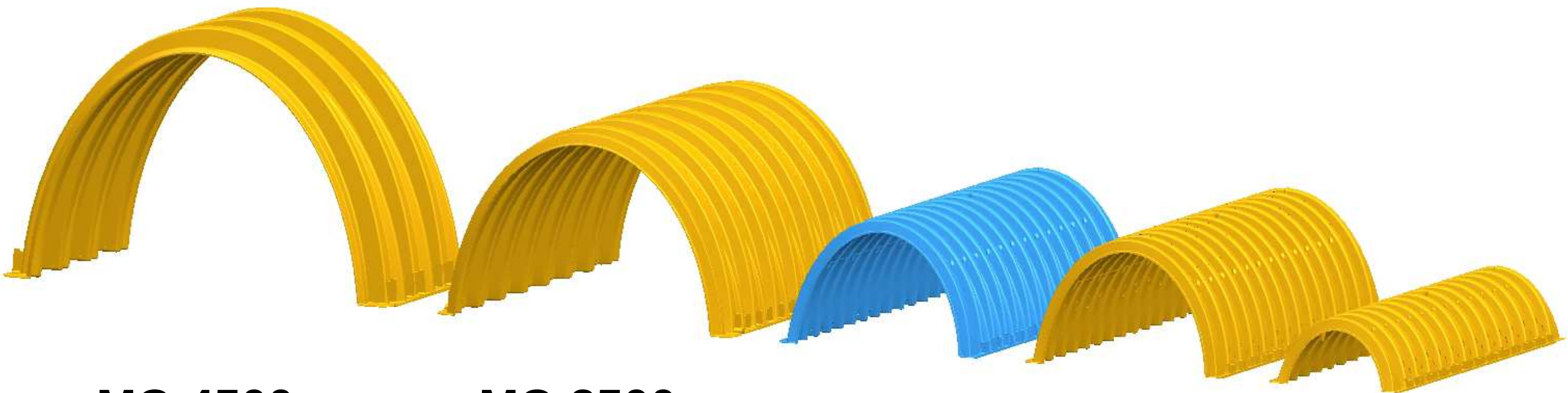
- 5 reasons to go underground
- Industry Standard Specifications
- Water Quality Expectations
- Recent Projects

Review of Chambers

Review of Chambers

The Complete Family of Products

MC-4500 vs 72" Perf pipe	MC-3500 vs 60" Perf Pipe	SC-740 vs 36" Perf. Pipe
MC-4500- 40.4 CF/LF	MC-3500 – 24.7 CF/LF	SC-740-10.5 CF/LF
72" Perf. Pipe – 37.8 CF/LF	60" Perf. Pipe – 27.6 CF/LF	36" Perf.Pipe-10.5 CF/LF

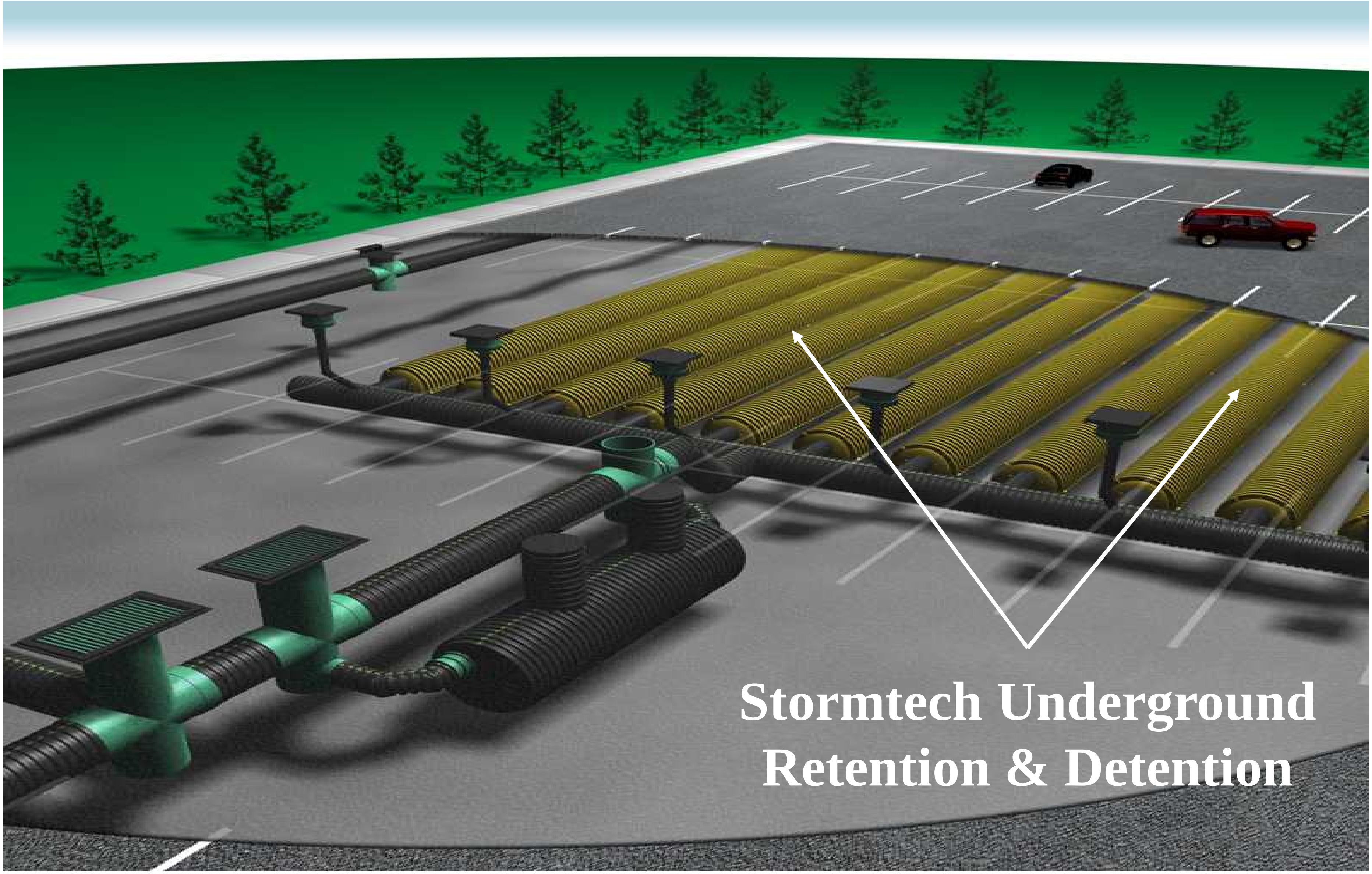


MC-4500 **MC-3500**

DC-780 **SC-740** **SC-310**

MEGA CHAMBER SERIES

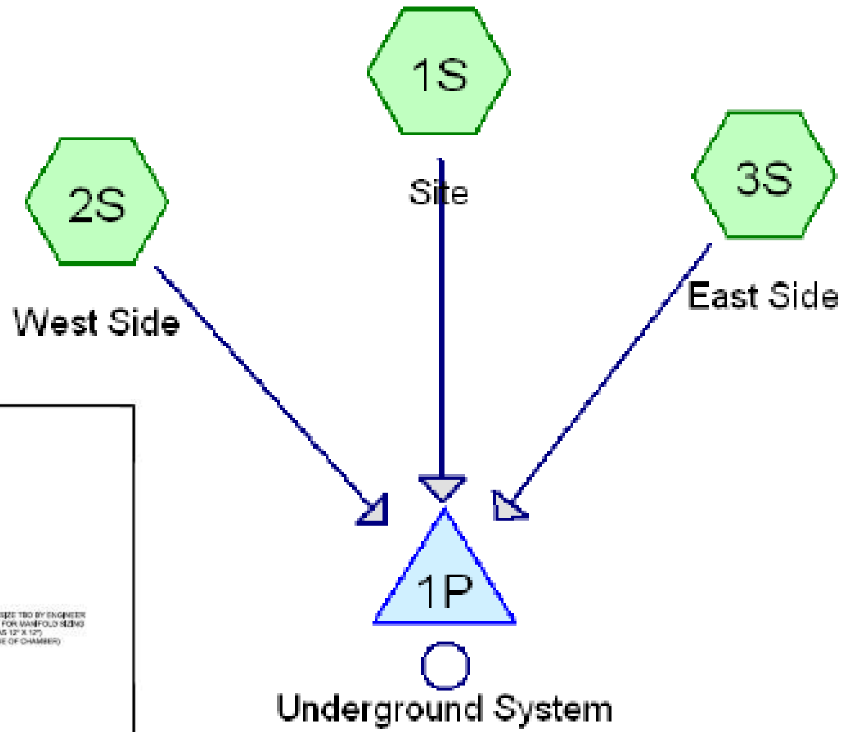
#1 – Efficient Land Use

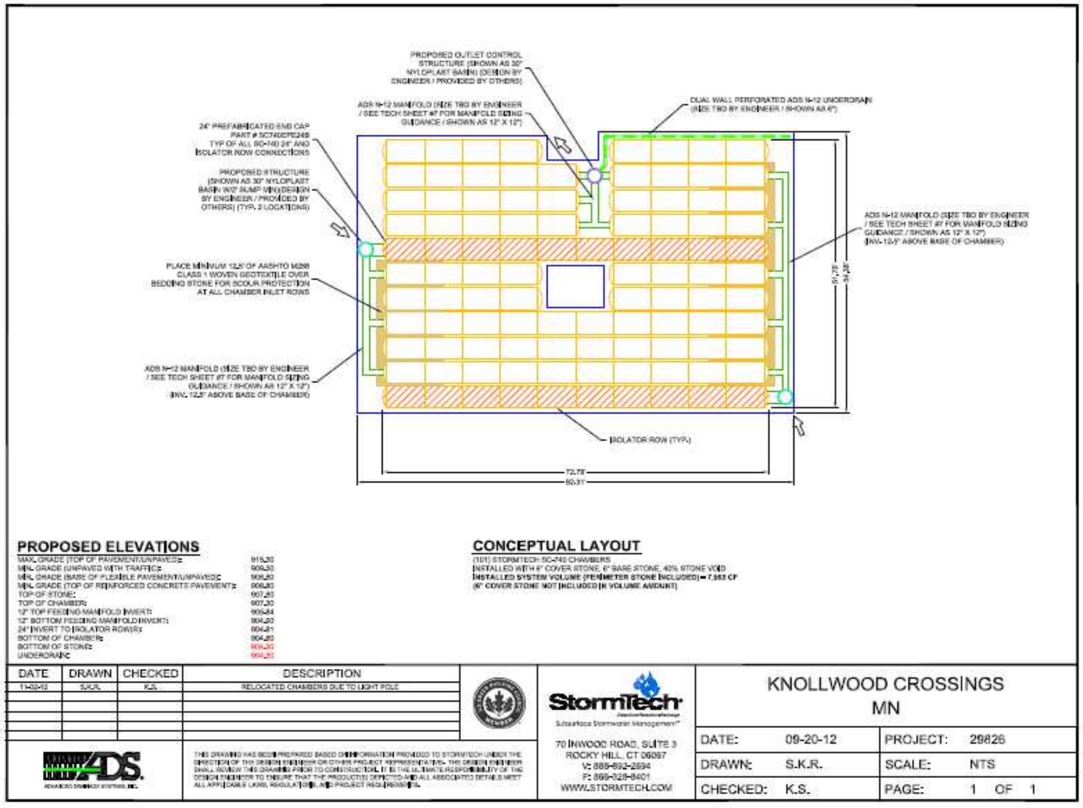


Review of Chambers

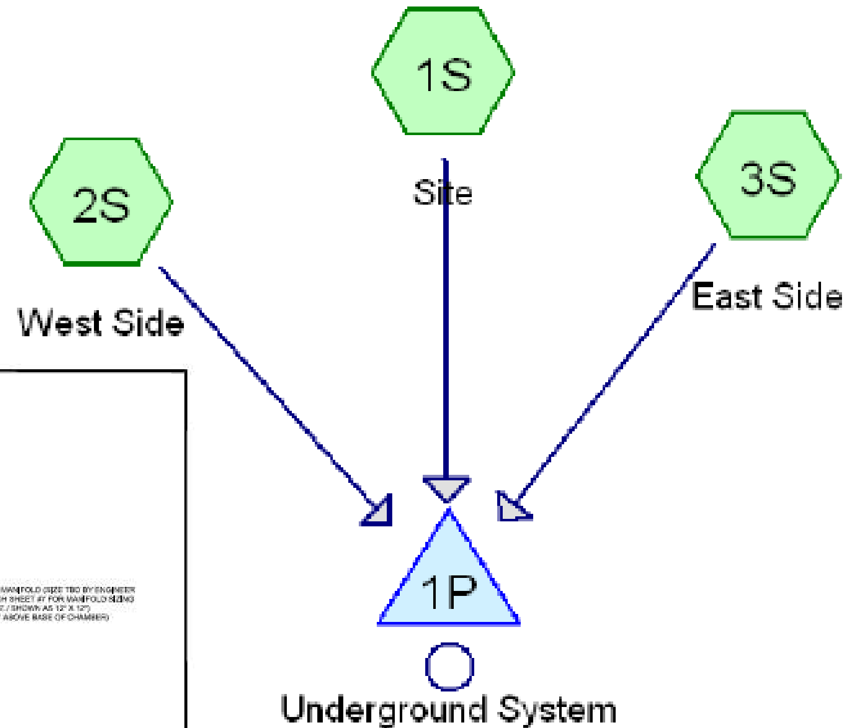
Why so widely used??

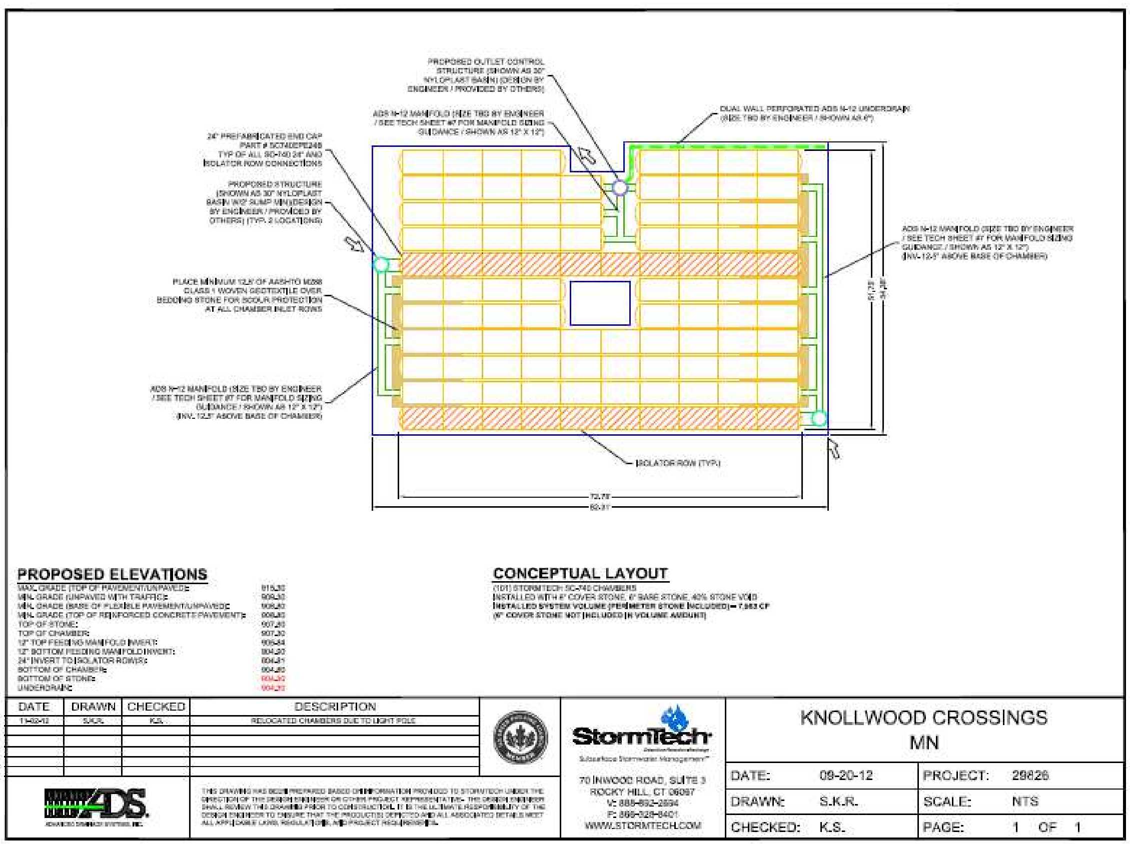
1) Efficient Land use
2) Easy to design



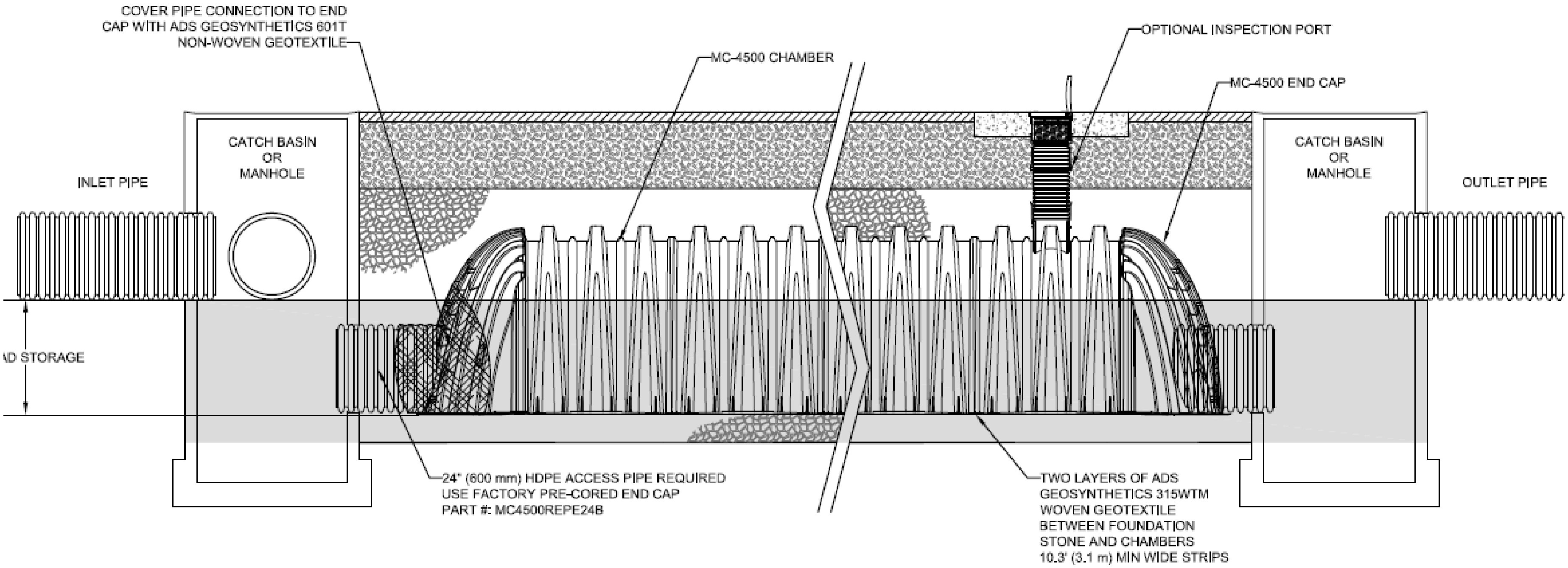


#2 Easy to Design





#3 Water Quality/Quantity Efficient



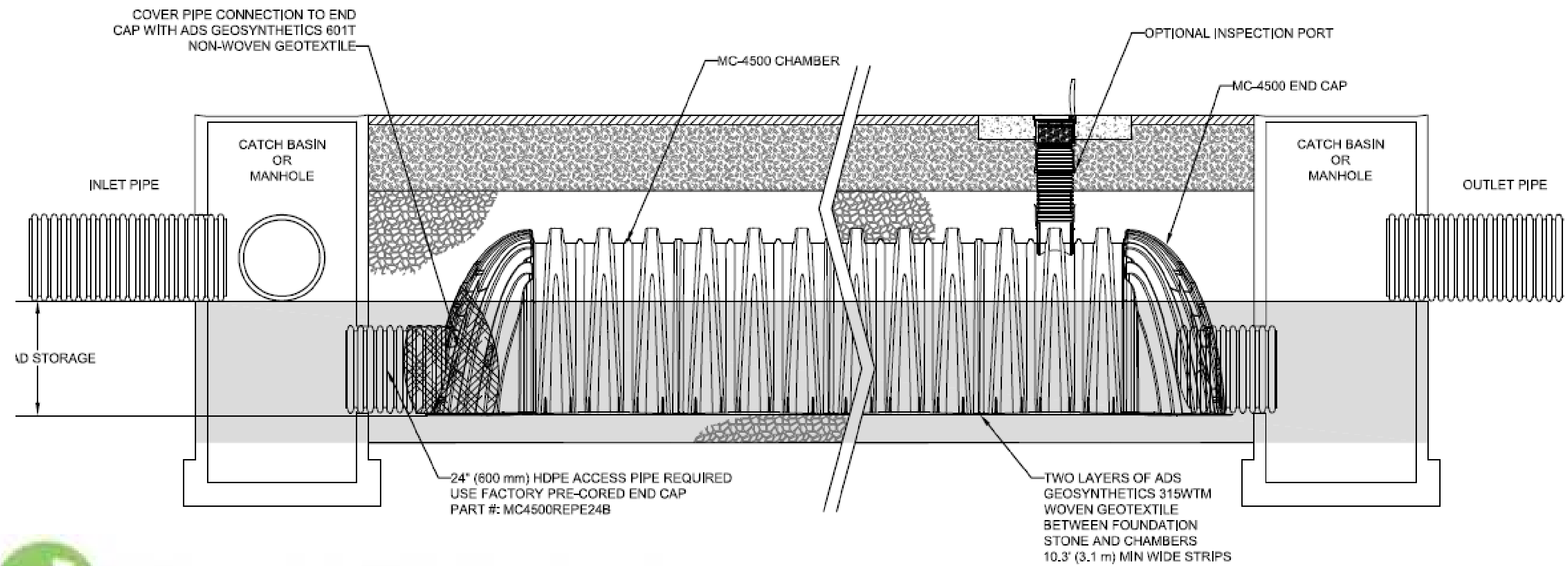
Minnesota Pollution Control Agency

NPDES

Review of Chambers

Why so widely used??

3)They are efficient from a water quality standpoint.



Minnesota Pollution Control Agency

NPDES

#4 Efficient Constructability

8 Basic Steps

StormTech
Detention • Retention • Water Quality
Division of ADS

Review of Chambers

Why so widely used??

4) Efficient from a constructability Standpoint

StormTech®
Detention • Retention • Water Quality
Division of ADS

Quick Install

1-EXCAVATE

2-FABRIC

3-BASE STONE

4-STAGE

5-CONNECT

6-STACK

Quick Install

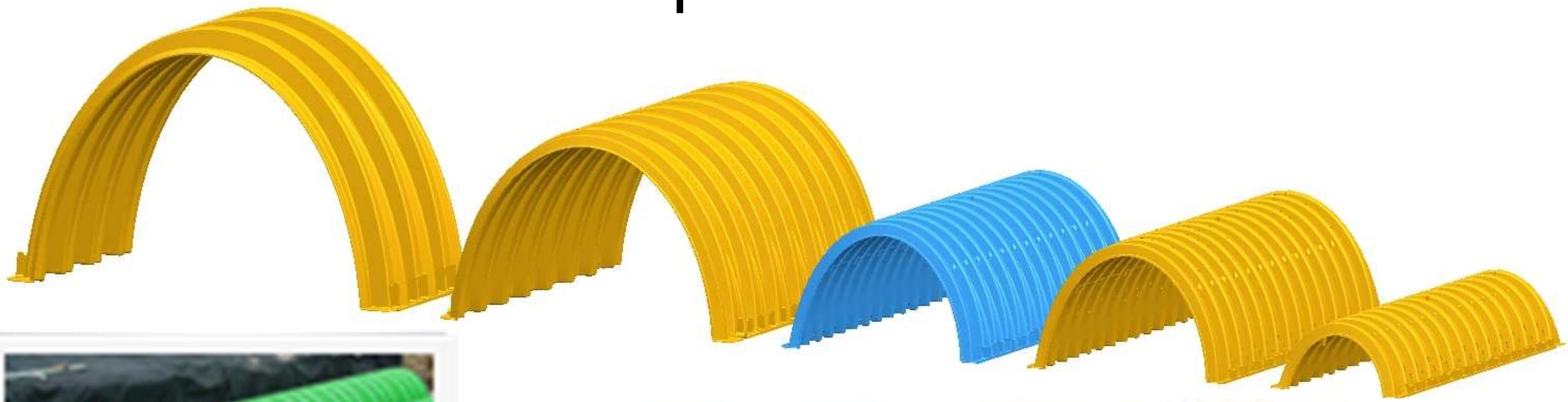
7-ROCK

8-COVER

Review of Chambers

StormTech
Detention • Retention • Water Quality

Industry Standard Specifications

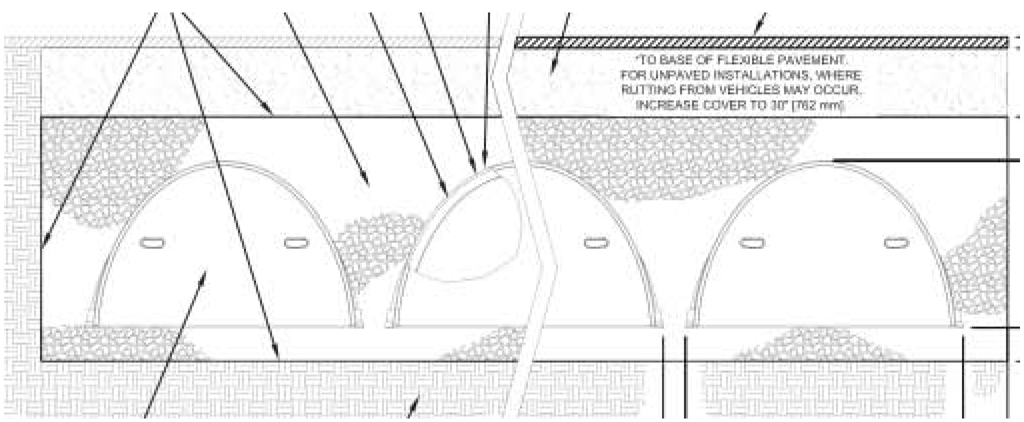


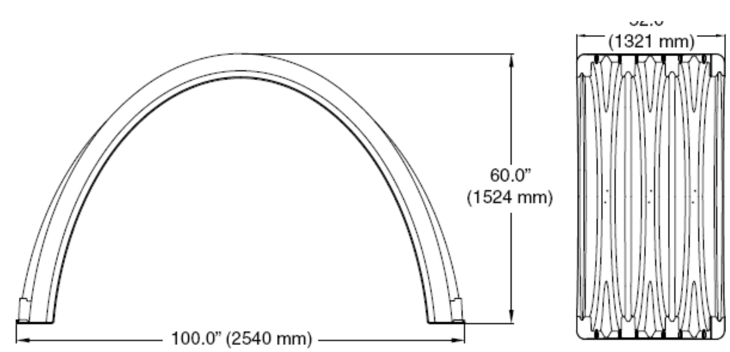
StormTech
Detention • Retention • Water Quality
Division of ADS

Industry Standard Specifications

What are the general design requirements for underground buried Thermoplastic Structures?
2 pieces

- The <u>Structural</u> component of the system
- <u>Material</u> component of the product manufactured





StormTech® Detention • Retention • Water Quality Division of ADS

Industry Standard Specifications

The structural design must evaluate short term, intermediate term, and long term soil loads. And be completed by experts in the field of soil-structure interaction. The system must be up to the standards that a professional engineer expects

The Materials used in production must also provide necessary short, intermediate, and long term properties. Product designed & manufactured to meet meaningful standards

This would be true for all buried products of various structural shapes and materials

Industry Standard Specifications

Without adherence to standards, regardless of the type of product, manufacturers' claims can be ambiguous

- The courts have found "the engineer" to be more culpable than the manufacturer
- National standards are developed by experts to be technically correct and reliable

Industry Standard Specifications

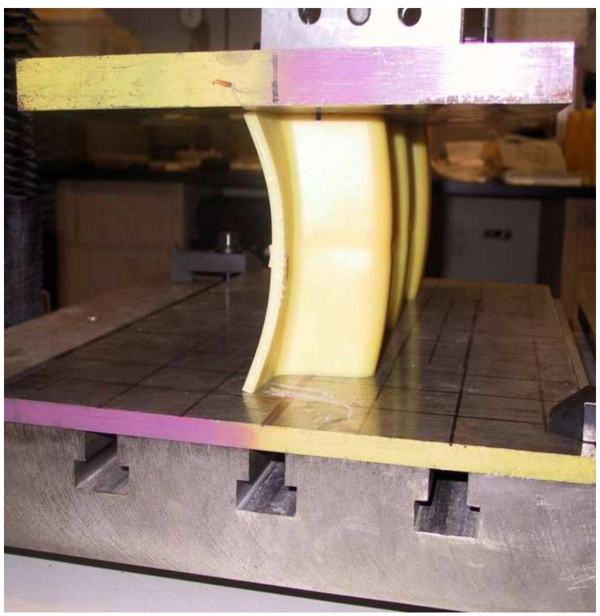
Specifying Industry Standards, not just products, establishes objective, meaningful performance criteria and a defensible basis of design.

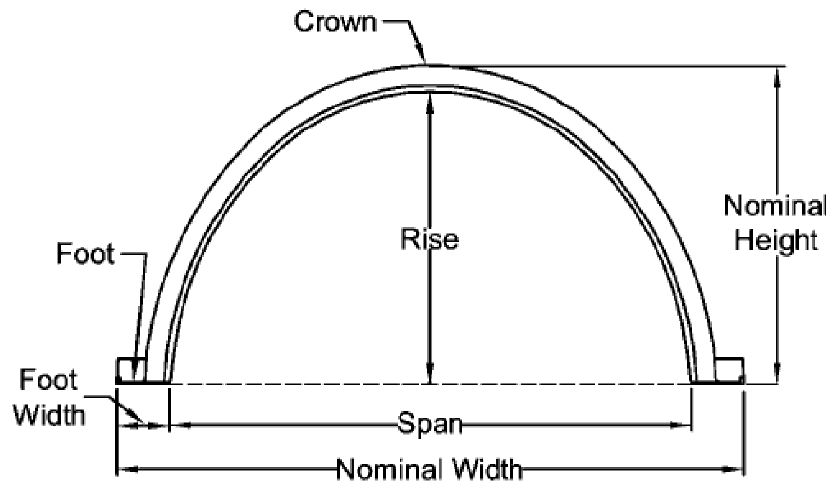
1 AASHTO is the American Association of State Highway and Transportation Officials
2 ASTM / ASTM International is the American Society of Testing Materials

Industry Standard Specifications

ASTM has developed the following <u>product</u> standards for stormwater chambers:

-**ASTM F2418** Polypropylene Corrugated Storm Chambers
-**ASTM F2922** Polyethylene Corrugated Storm Chambers





Industry Standard Specifications

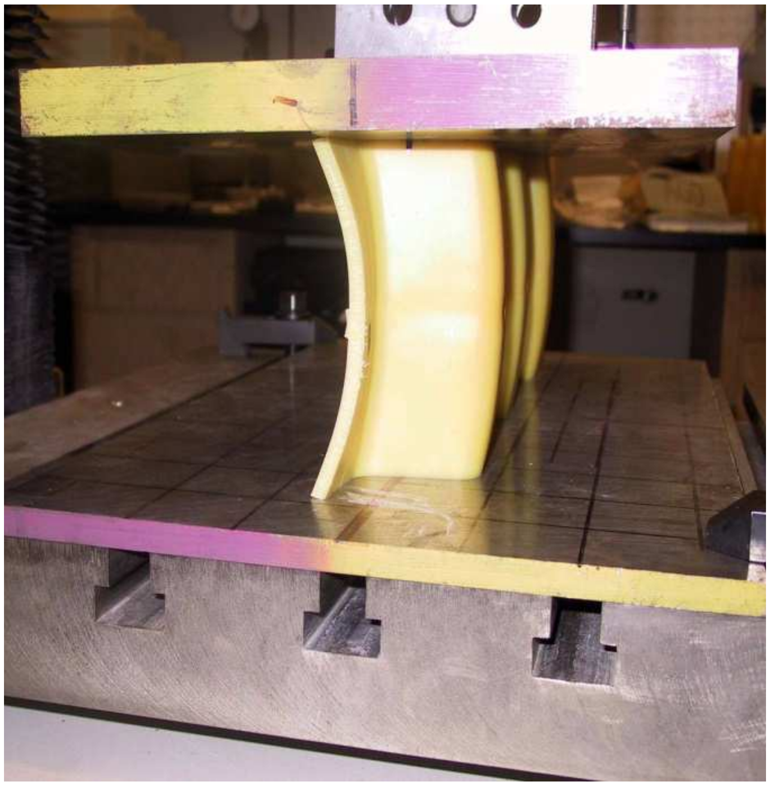
Material and Manufacture

PP0330B99945

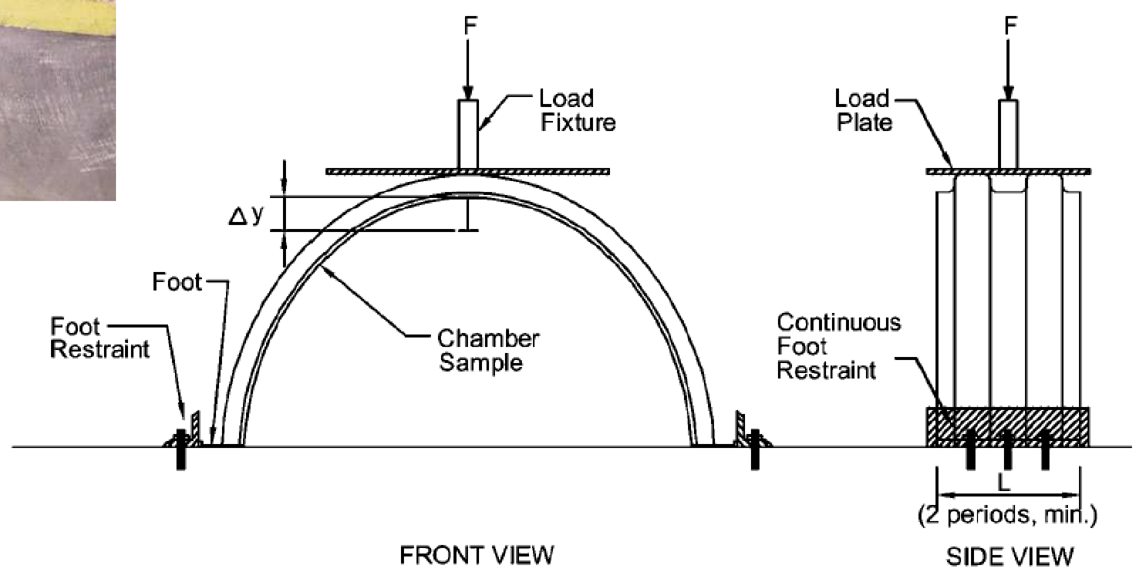
516500C or E

- Density
- Tensile Strength
- Elongation Modulus
- Melt flow rate
- UV Resistance
- Short & Long term Material Properties

Industry Standard Specifications



- Wall Thickness
- Dimensions/Shape
- Arch Stiffness Constant
- Impact Resistance
- Mechanical & Physical Properties



Industry Standard Specifications

Soil-Structure interaction :

AASHTO LRFD Bridge Design Specification

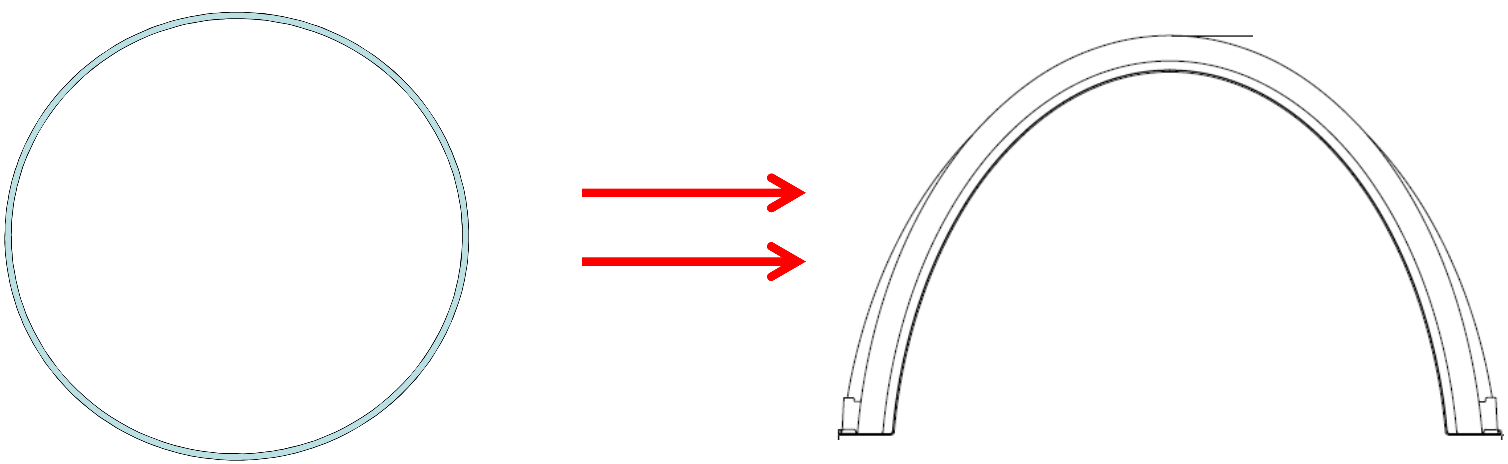
-Section 3 – Loading Calculations

-Section 12.12 Structural Design of TP Structures

Industry Standard Specifications

ASTM F2787 – Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers

.



Pipe

Chamber

Industry Standard Specifications

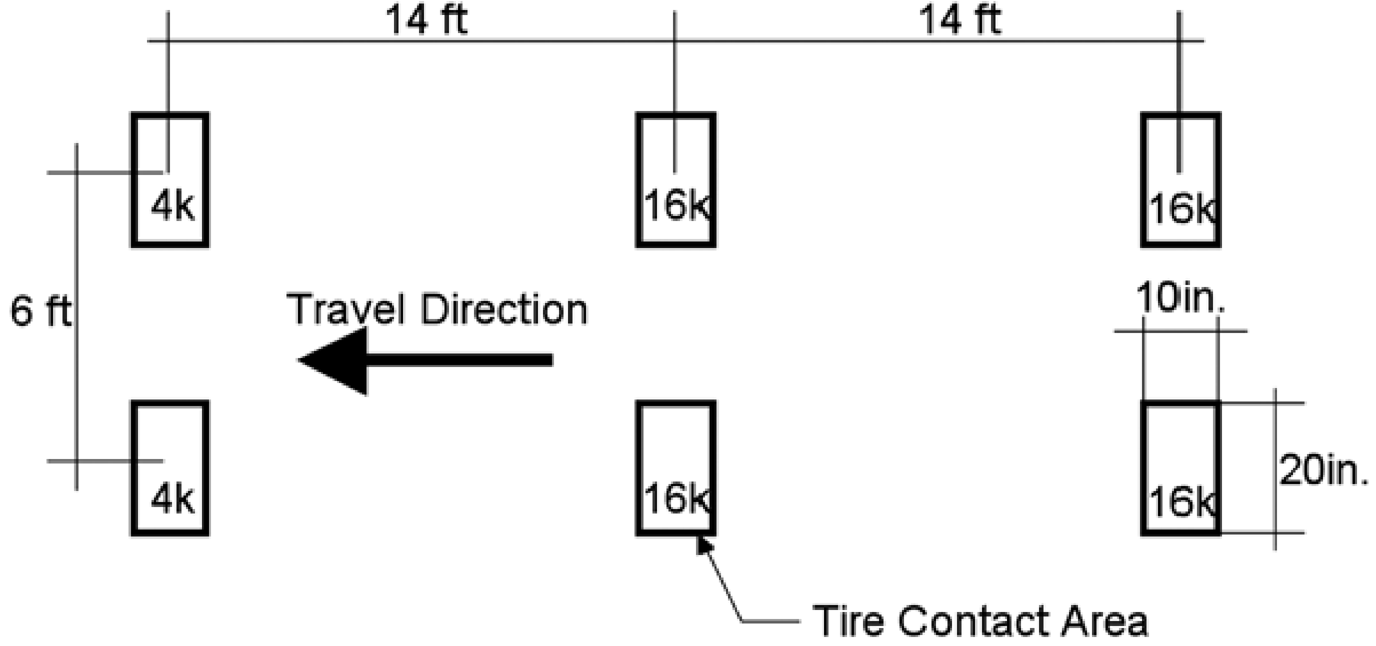


FIG. A1.1 Characteristics of Design Truck and Design Tire Contact Area

Utilizes the HL93 AASHTO Design Truck (former HS-20)

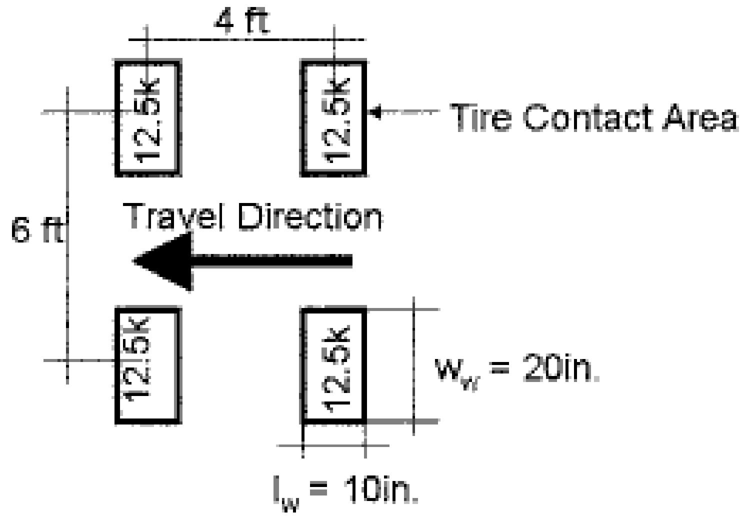


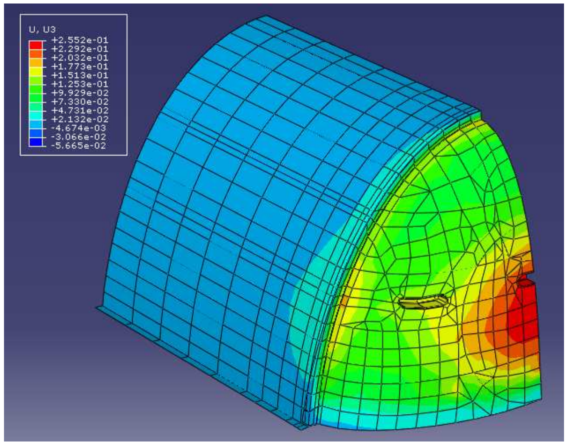
FIG. A1.2 Characteristics of Design Tandem

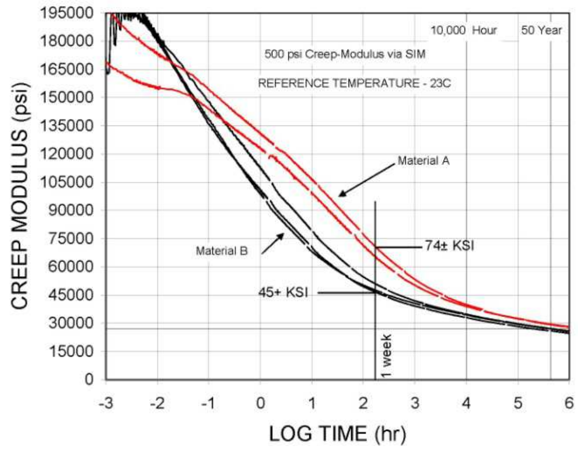
Or the AASHTO Design Tandem (former HS-20)

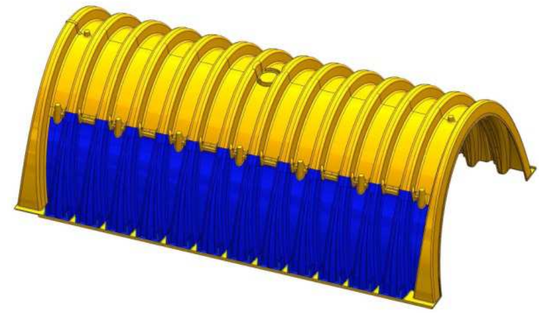
Needs to meet LRFD load & Resistance design factors
For HL93:

- Live Loads
- Impact
- Multiple Presence Factors

Industry Standard Specifications







Computer Modeling (FEA – CANDE) is used to:

- Analyze Resin Properties
- Chamber Shape, Corrugation Profile, Wall Thickness
- Bedding/backfill Min/Max Covers per Details

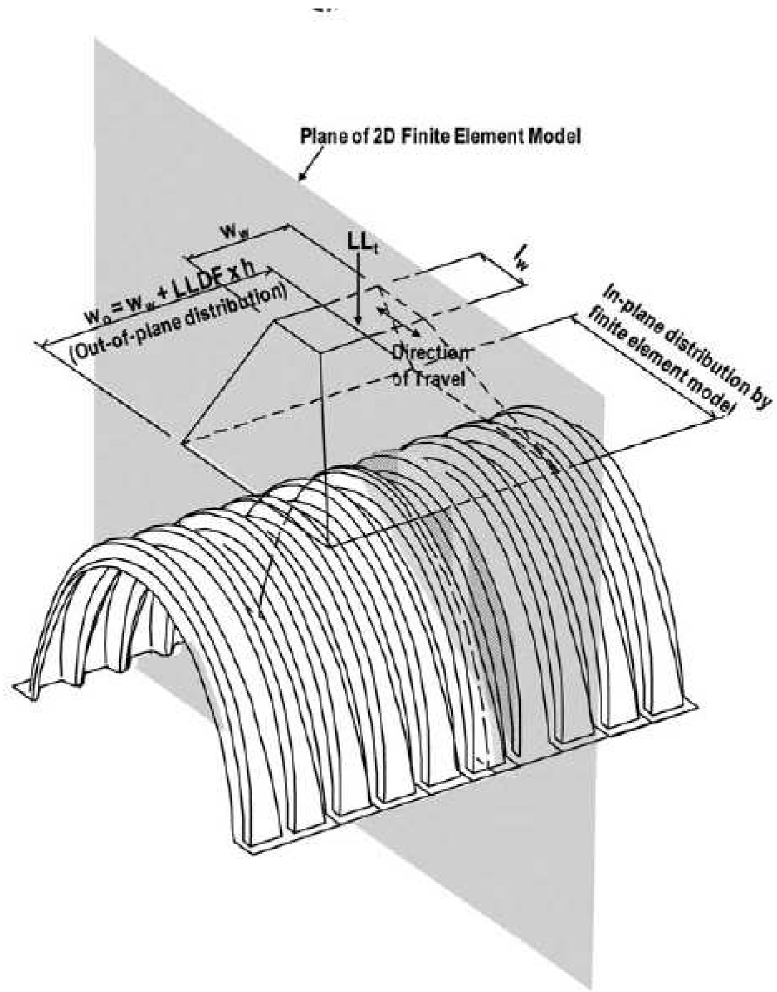
StormTech
Detention • Retention • Water Quality
Division of ADS

Industry Standard Specifications

Full Scale testing used to determine if chamber design Acceptable – when FS exceed:

1.75 for Live loads

1.95 for Dead loads



Industry Standard Specifications

Shallow Cover Testing:

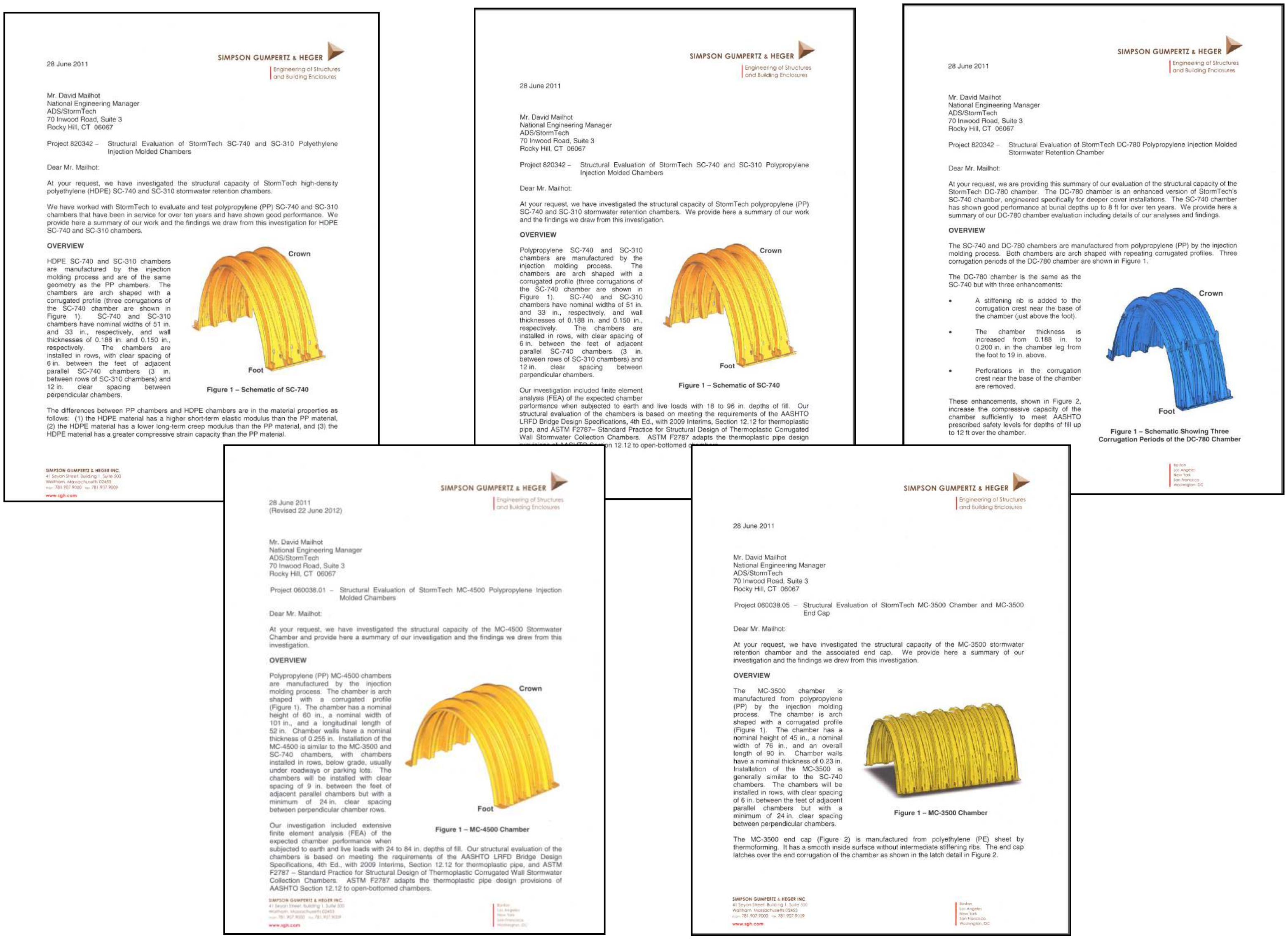
- 27kips – 35kips/axle
- 12”-18”/11”-4” rutted cover
- Low speed passes on Crown/Shoulder
- 10 min Static holds
- 100 Low speed passes
- Exceeds resist full factored AASHTO loads @ 18”- 78” cover

Industry Standard Specifications

Deep Cover Testing:

- 12.6FT – 17.3Ft Cover
- Zero spacing between Chambers
- 8.5 months
- Exceeds resist full factored AASHTO loads @ 18"- 78" cover

Industry Standard Specifications



SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

28 June 2011

Mr. David Mailhot
National Engineering Manager
ADS/StormTech
70 Inwood Road, Suite 3
Rocky Hill, CT 06067

Project 820342 – Structural Evaluation of StormTech SC-740 and SC-310 Polyethylene Injection Molded Chambers

Dear Mr. Mailhot:

At your request, we have investigated the structural capacity of StormTech high-density polyethylene (HDPE) SC-740 and SC-310 stormwater retention chambers.

We have worked with StormTech to evaluate and test polypropylene (PP) SC-740 and SC-310 chambers that have been in service for over ten years and have shown good performance. We provide here a summary of our work and the findings we draw from this investigation for HDPE SC-740 and SC-310 chambers.

OVERVIEW

HDPE SC-740 and SC-310 chambers are manufactured by the injection molding process and are of the same geometry as the PP chambers. The chambers are arch shaped with a corrugated profile (three corrugations of the SC-740 chamber are shown in Figure 1). SC-740 and SC-310 chambers have nominal widths of 51 in. and 33 in., respectively, and wall thicknesses of 0.188 in. and 0.150 in., respectively. The chambers are installed in rows, with clear spacing of 6 in. between the feet of adjacent parallel SC-740 chambers (3 in. between rows of SC-310 chambers) and 12 in. clear spacing between perpendicular chambers.

Crown
Foot
Figure 1 – Schematic of SC-740

The differences between PP chambers and HDPE chambers are in the material properties as follows: (1) the HDPE material has a higher short-term elastic modulus than the PP material, (2) the HDPE material has a lower long-term creep modulus than the PP material, and (3) the HDPE material has a greater compressive strain capacity than the PP material.

SIMPSON GUMPERTZ & HEGER INC.
41 Seyon Street, Building 1, Suite 500
Waltham, Massachusetts 02453
main: 781.907.9000 fax: 781.907.9009
www.sgh.com

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

28 June 2011

Mr. David Mailhot
National Engineering Manager
ADS/StormTech
70 Inwood Road, Suite 3
Rocky Hill, CT 06067

Project 820342 – Structural Evaluation of StormTech SC-740 and SC-310 Polypropylene Injection Molded Chambers

Dear Mr. Mailhot:

At your request, we have investigated the structural capacity of StormTech polypropylene (PP) SC-740 and SC-310 stormwater retention chambers. We provide here a summary of our work and the findings we draw from this investigation.

OVERVIEW

Polypropylene SC-740 and SC-310 chambers are manufactured by the injection molding process. The chambers are arch shaped with a corrugated profile (three corrugations of the SC-740 chamber are shown in Figure 1). SC-740 and SC-310 chambers have nominal widths of 51 in. and 33 in., respectively, and wall thicknesses of 0.188 in. and 0.150 in., respectively. The chambers are installed in rows, with clear spacing of 6 in. between the feet of adjacent parallel SC-740 chambers (3 in. between rows of SC-310 chambers) and 12 in. clear spacing between perpendicular chambers.

Crown
Foot
Figure 1 – Schematic of SC-740

Our investigation included finite element analysis (FEA) of the expected chamber performance when subjected to earth and live loads with 18 to 96 in. depths of fill. Our structural evaluation of the chambers is based on meeting the requirements of the AASHTO LRFD Bridge Design Specifications, 4th Ed., with 2009 Interims, Section 12.12 for thermoplastic pipe, and ASTM F2787– Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. ASTM F2787 adapts the thermoplastic pipe design provisions of AASHTO Section 12.12 to open-bottomed chambers.

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

28 June 2011

Mr. David Mailhot
National Engineering Manager
ADS/StormTech
70 Inwood Road, Suite 3
Rocky Hill, CT 06067

Project 820342 – Structural Evaluation of StormTech DC-780 Polypropylene Injection Molded Stormwater Retention Chamber

Dear Mr. Mailhot:

At your request, we are providing this summary of our evaluation of the structural capacity of the StormTech DC-780 chamber. The DC-780 chamber is an enhanced version of StormTech's SC-740 chamber, engineered specifically for deeper cover installations. The SC-740 chamber has shown good performance at burial depths up to 8 ft for over ten years. We provide here a summary of our DC-780 chamber evaluation including details of our analyses and findings.

OVERVIEW

The SC-740 and DC-780 chambers are manufactured from polypropylene (PP) by the injection molding process. Both chambers are arch shaped with repeating corrugated profiles. Three corrugation periods of the DC-780 chamber are shown in Figure 1.

The DC-780 chamber is the same as the SC-740 but with three enhancements:

- A stiffening rib is added to the corrugation crest near the base of the chamber (just above the foot).
- The chamber thickness is increased from 0.188 in. to 0.200 in. in the chamber leg from the foot to 19 in. above.
- Perforations in the corrugation crest near the base of the chamber are removed.

These enhancements, shown in Figure 2, increase the compressive capacity of the chamber sufficiently to meet AASHTO prescribed safety levels for depths of fill up to 12 ft over the chamber.

Crown
Foot
Figure 1 – Schematic Showing Three Corrugation Periods of the DC-780 Chamber

Boston
Los Angeles
New York
San Francisco
Washington, DC

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

28 June 2011
(Revised 22 June 2012)

Mr. David Mailhot
National Engineering Manager
ADS/StormTech
70 Inwood Road, Suite 3
Rocky Hill, CT 06067

Project 060038.01 – Structural Evaluation of StormTech MC-4500 Polypropylene Injection Molded Chambers

Dear Mr. Mailhot:

At your request, we have investigated the structural capacity of the MC-4500 Stormwater Chamber and provide here a summary of our investigation and the findings we drew from this investigation.

OVERVIEW

Polypropylene (PP) MC-4500 chambers are manufactured by the injection molding process. The chamber is arch shaped with a corrugated profile (Figure 1). The chamber has a nominal height of 60 in., a nominal width of 101 in., and a longitudinal length of 52 in. Chamber walls have a nominal thickness of 0.255 in. Installation of the MC-4500 is similar to the MC-3500 and SC-740 chambers, with chambers installed in rows, below grade, usually under roadways or parking lots. The chambers will be installed with clear spacing of 9 in. between the feet of adjacent parallel chambers but with a minimum of 24 in. clear spacing between perpendicular chamber rows.

Crown
Foot
Figure 1 – MC-4500 Chamber

Our investigation included extensive finite element analysis (FEA) of the expected chamber performance when subjected to earth and live loads with 24 to 84 in. depths of fill. Our structural evaluation of the chambers is based on meeting the requirements of the AASHTO LRFD Bridge Design Specifications, 4th Ed., with 2009 Interims, Section 12.12 for thermoplastic pipe, and ASTM F2787 – Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. ASTM F2787 adapts the thermoplastic pipe design provisions of AASHTO Section 12.12 to open-bottomed chambers.

SIMPSON GUMPERTZ & HEGER INC.
41 Seyon Street, Building 1, Suite 500
Waltham, Massachusetts 02453
main: 781.907.9000 fax: 781.907.9009
www.sgh.com

Boston
Los Angeles
New York
San Francisco
Washington, DC

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

28 June 2011

Mr. David Mailhot
National Engineering Manager
ADS/StormTech
70 Inwood Road, Suite 3
Rocky Hill, CT 06067

Project 060038.05 – Structural Evaluation of StormTech MC-3500 Chamber and MC-3500 End Cap

Dear Mr. Mailhot:

At your request, we have investigated the structural capacity of the MC-3500 stormwater retention chamber and the associated end cap. We provide here a summary of our investigation and the findings we drew from this investigation.

OVERVIEW

The MC-3500 chamber is manufactured from polypropylene (PP) by the injection molding process. The chamber is arch shaped with a corrugated profile (Figure 1). The chamber has a nominal height of 45 in., a nominal width of 76 in., and an overall length of 90 in. Chamber walls have a nominal thickness of 0.23 in. Installation of the MC-3500 is generally similar to the SC-740 chambers. The chambers will be installed in rows, with clear spacing of 6 in. between the feet of adjacent parallel chambers but with a minimum of 24 in. clear spacing between perpendicular chambers.

Figure 1 – MC-3500 Chamber

The MC-3500 end cap (Figure 2) is manufactured from polyethylene (PE) sheet by thermoforming. It has a smooth inside surface without intermediate stiffening ribs. The end cap latches over the end corrugation of the chamber as shown in the latch detail in Figure 2.

SIMPSON GUMPERTZ & HEGER INC.
41 Seyon Street, Building 1, Suite 500
Waltham, Massachusetts 02453
main: 781.907.9000 fax: 781.907.9009
www.sgh.com

Boston
Los Angeles
New York
San Francisco
Washington, DC

CLAIMS 5X AASHTO!

Largest Wheel load tested = 12,750 lbs

AASHTO = 16,000 lbs

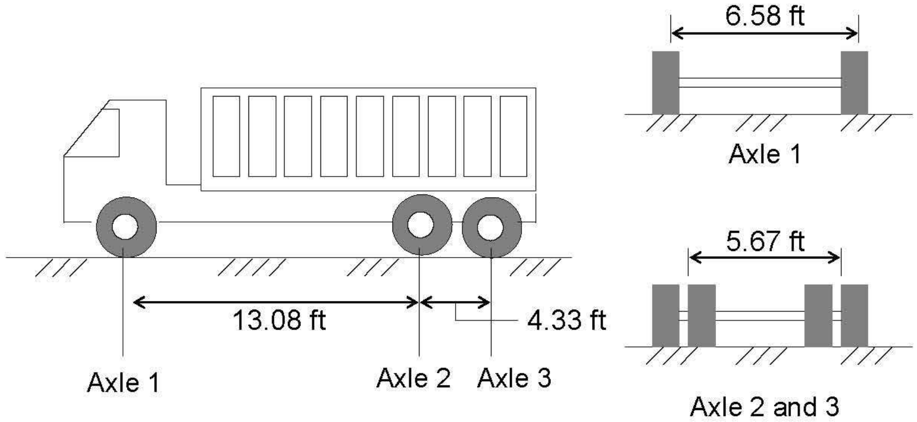


Figure 25: Axle Configurations of Actual Dump Truck Utilized

Table 5: Wheel and Axle Loads Measured in Field

Level 1: Wheel & Axle Loads - Empty Dump Truck: 12.95-kip Loading on Rear Axles			
	Axle 1 (Front)	Axle 2 (Center)	Axle 3 (Rear)
Right Side	4,450 lb	2,500 lb; 900 lb	1,850 lb; 1,300 lb
Left Side	5,000 lb	2,000 lb; 1,200 lb	2,150 lb; 1,050 lb
Total	9,450 lb	6,600 lb	6.350 lb
Level 2: Wheel & Axle Loads - HS-20 (32-kip) Loading on Rear Axles			
	Axle 1 (Front)	Axle 2 (Center)	Axle 3 (Rear)
Right Side	5.700 lb	5,400 lb; 2,750 lb	5,550 lb; 3,000 lb
Left Side	6,100 lb	3,950 lb; 3,750 lb	4,250 lb; 3,750 lb
Total	11,800 lb	15,850 lb	16,550 lb
Level 3: Wheel & Axle Loads - HS-25 (40-kip) Loading on Rear Axles			
	Axle 1 (Front)	Axle 2 (Center)	Axle 3 (Rear)
Right Side	7,000 lb	6,250 lb; 4,200 lb	6,000 lb; 5,250 lb
Left Side	6,400 lb	5,050 lb; 4,900 lb	4,600 lb; 4,150 lb
Total	13,400 lb	20,400 lb	20,000 lb
Level 4: Wheel & Axle Loads - 48-kip Loading on Rear Axles			
	Axle 1 (Front)	Axle 2 (Center)	Axle 3 (Rear)
Right Side	NA	7,450 lb; 5,300 lb	6,450 lb; 5,350 lb
Left Side	NA	6,200 lb; 5,550 lb	5,850 lb; 5,850 lb
Total	NA	24,500 lb	23,500 lb

Sample Calculation

W = 8,000 lbs (32,000 lb axle / 4 wheels/axle)
F_d = 1.2
A = 1661 si (18" cover w/45 degree angle)
dy = 1.35 psi (18 ci saturated sand @ 130 lbs/cf)

σ_{va} = (8,000 lbs x 1.2 / 1661 si) + 1.35 lbs

σ_{va} = 7.13 psi

Safety Factor = 4.77

(34 psi ultimate bearing capacity / 7.13 psi applied load)

AASHTO

W = **16,000 lbs** (32,000 lb/ single axle)

F_d = m = 1.2 (multiple presence)

M? = 1.27 (dynamic impact factor for 18" cover)

A = (1.15*18" +20")(1.15*18 + 10") = 1249.49 in^2

Dy = 1.25 psi (soil load under 18" @ 120pcf)

- 130 pcf is conservative

σ live load = $\frac{(16{,}000 lbs)(1.2)(1.27)}{1249.49\ in^2}$ + 1.25 psi = 20.7 psi

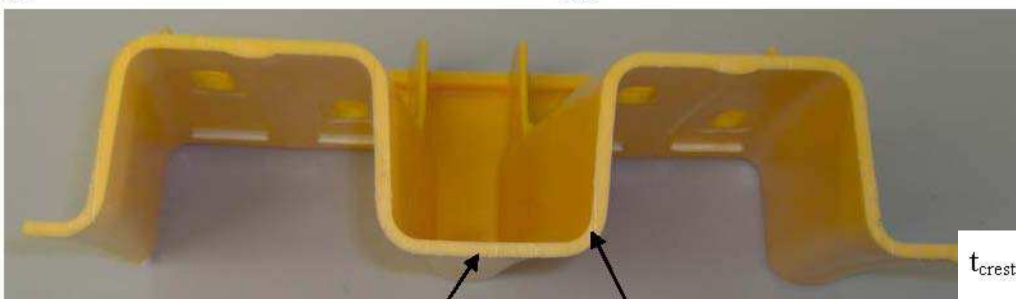
Safety Factor = 34/20.7 = 1.64 <1.75 LL SF from AASHTO!!!

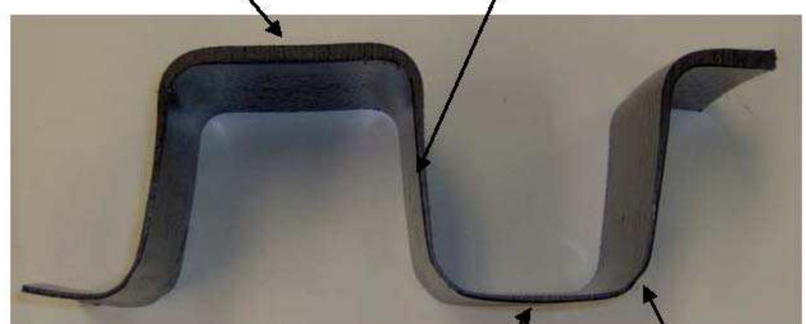
StormTech®

Detention • Retention • Water Quality

Division of ADS

PRODUCT QUALITY CONTROL





StormTech®
Detention • Retention • Water Quality
Division of ADS

All credible manufacturers will meet these national standards…

ASTM F2922 – Polyethylene Corrugated Stormwater Chambers

ASTM F2418 – Polypropylene Corrugated Stormwater Chambers

ASTM F2787 – Structural Design of TP Corrugated Chambers

StormTech®
Detention • Retention • Water Quality
Division of ADS

Specification for Thermoplastic Stormwater Collection Chambers

2621.1 DESCRIPTION

ASTM F2418 Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
ASTM F2922 Standard Specification for Polyethylene (PE) Corrugated Wall Stormwater Collection Chambers
ASTM F2787 Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers

Thermoplastic Stormwater Collection Chambers

Thermoplastic stormwater chambers shall conform to ASTM F2418 and/or ASTM F2922 Chambers shall be made from virgin, impact-modified polypropylene or high density polyethylene copolymers. Chamber rows shall provide continuous, unobstructed internal space with no internal support panels that would impede flow or limit access for inspection.

The structural design of the chambers, the structural backfill and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presences.

Chambers shall conform to the requirements of ASTM F2787, “Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers".

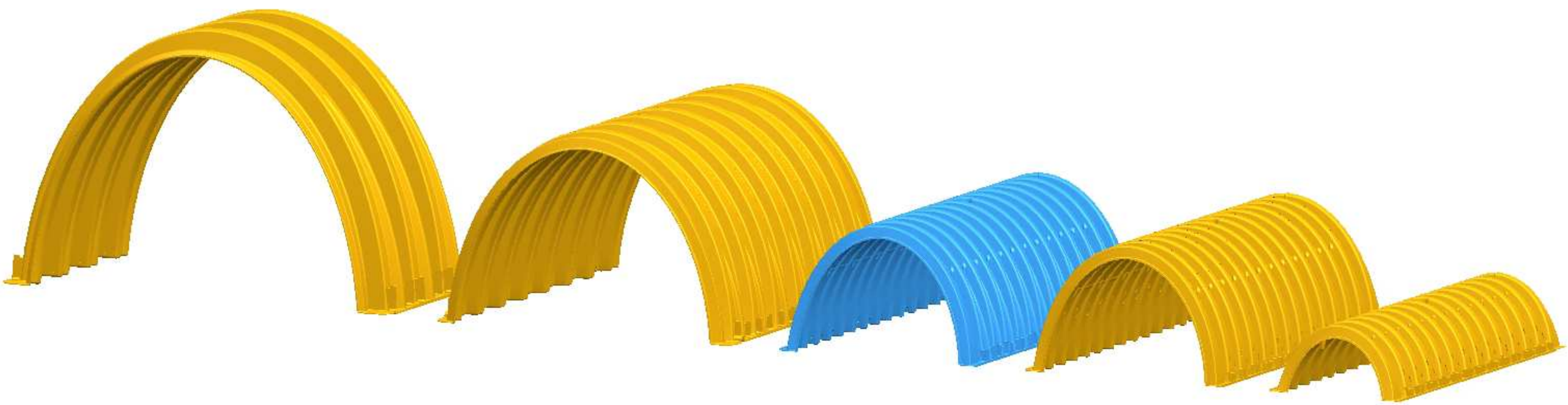
Only chambers that are approved by the engineer will be allowed. The contractor shall submit (3 sets) of the following to the engineer for approval before delivering chambers to the project site:

A) A structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 is met.
B) Structural cross section detail on which the structural cross section is based.

The installation of chambers shall be in accordance with the manufacturer's latest installation instructions.

The Complete Family of Products

MC-4500 <u>vs</u> 72” Perf pipe	MC-3500 <u>vs</u> 60” Perf Pipe	SC-740 <u>vs</u> 36” Perf. Pipe
MC-4500- 40.4 CF/LF	MC-3500 – 24.7 CF/LF	SC-740-10.5 CF/LF
72” Perf. Pipe – 37.8 CF/LF	60” Perf. Pipe – 27.6 CF/LF	36” Perf.Pipe-10.5 CF/LF

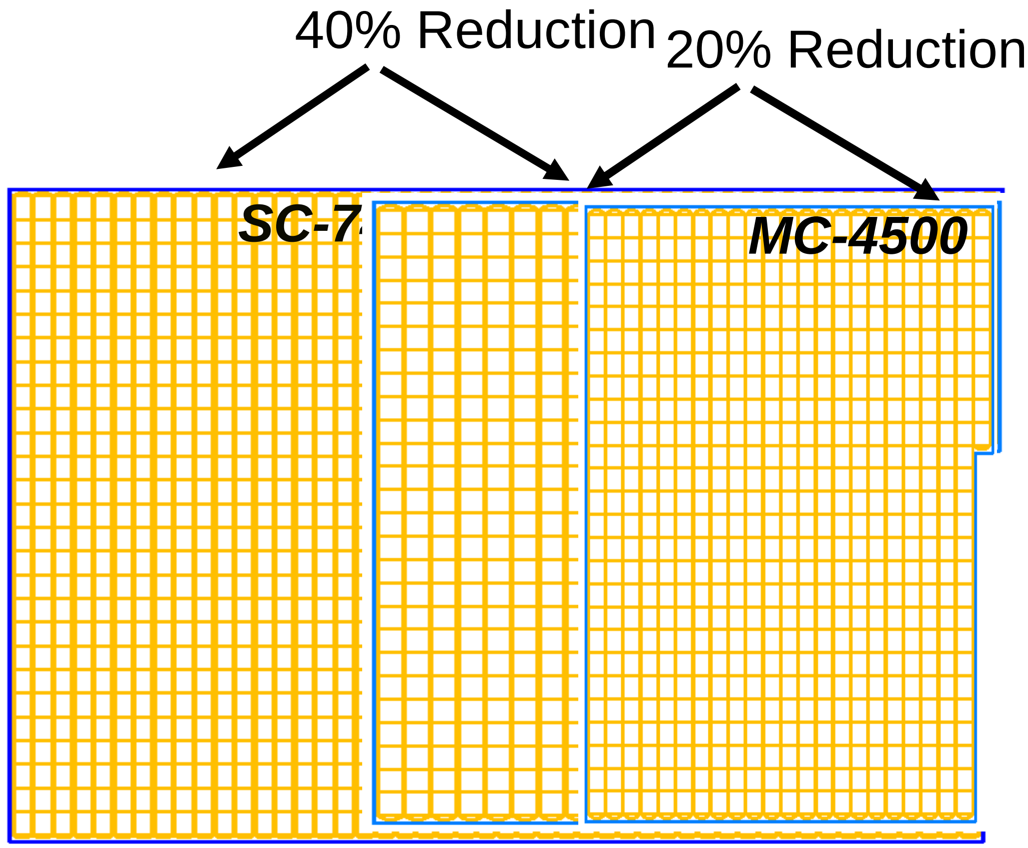


MC-4500 **MC-3500** **DC-780** **SC-740** **SC-310**

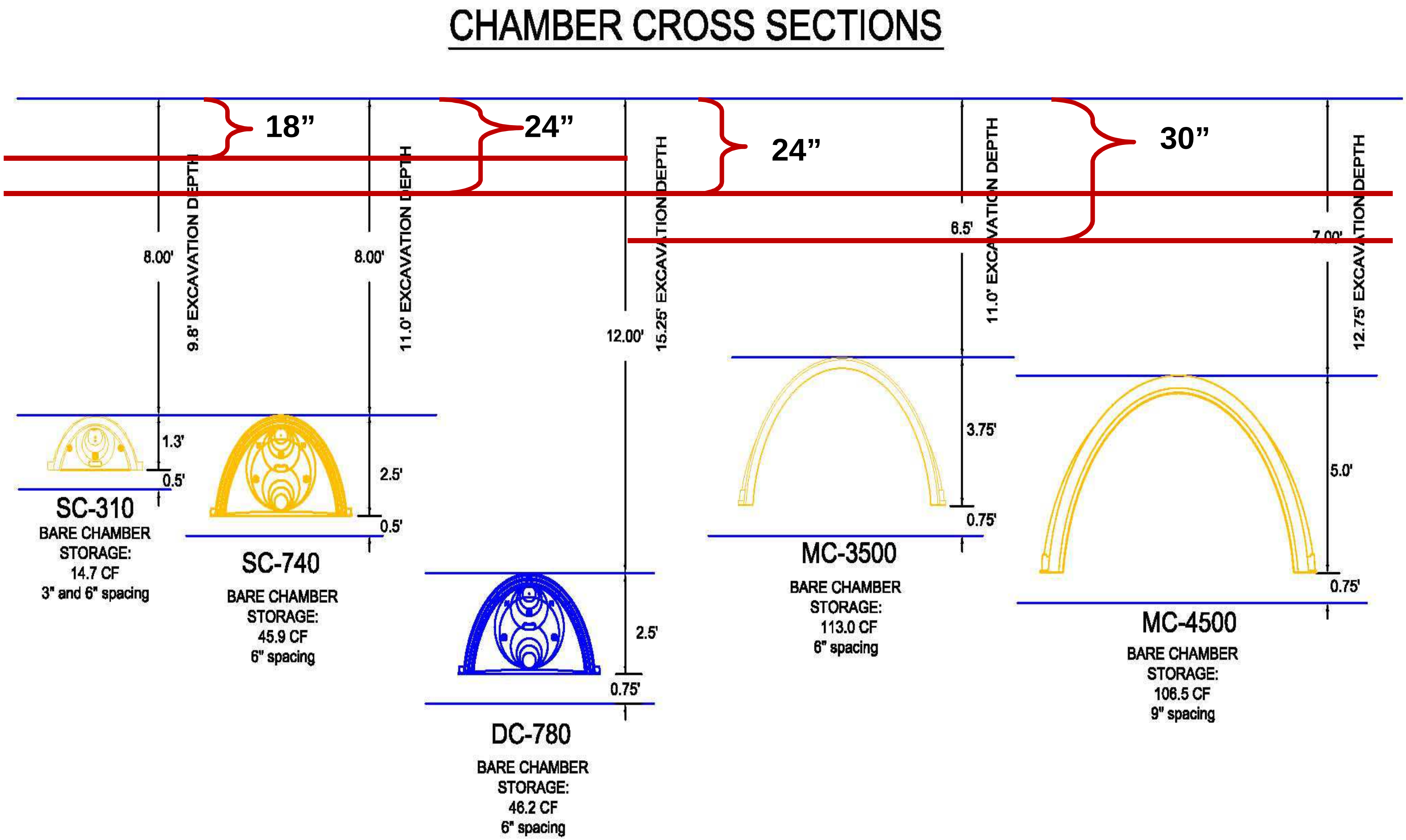
MEGA CHAMBER SERIES

Footprint Comparison - 100,000 cf

SC-740 / MC-3500 / MC-4500

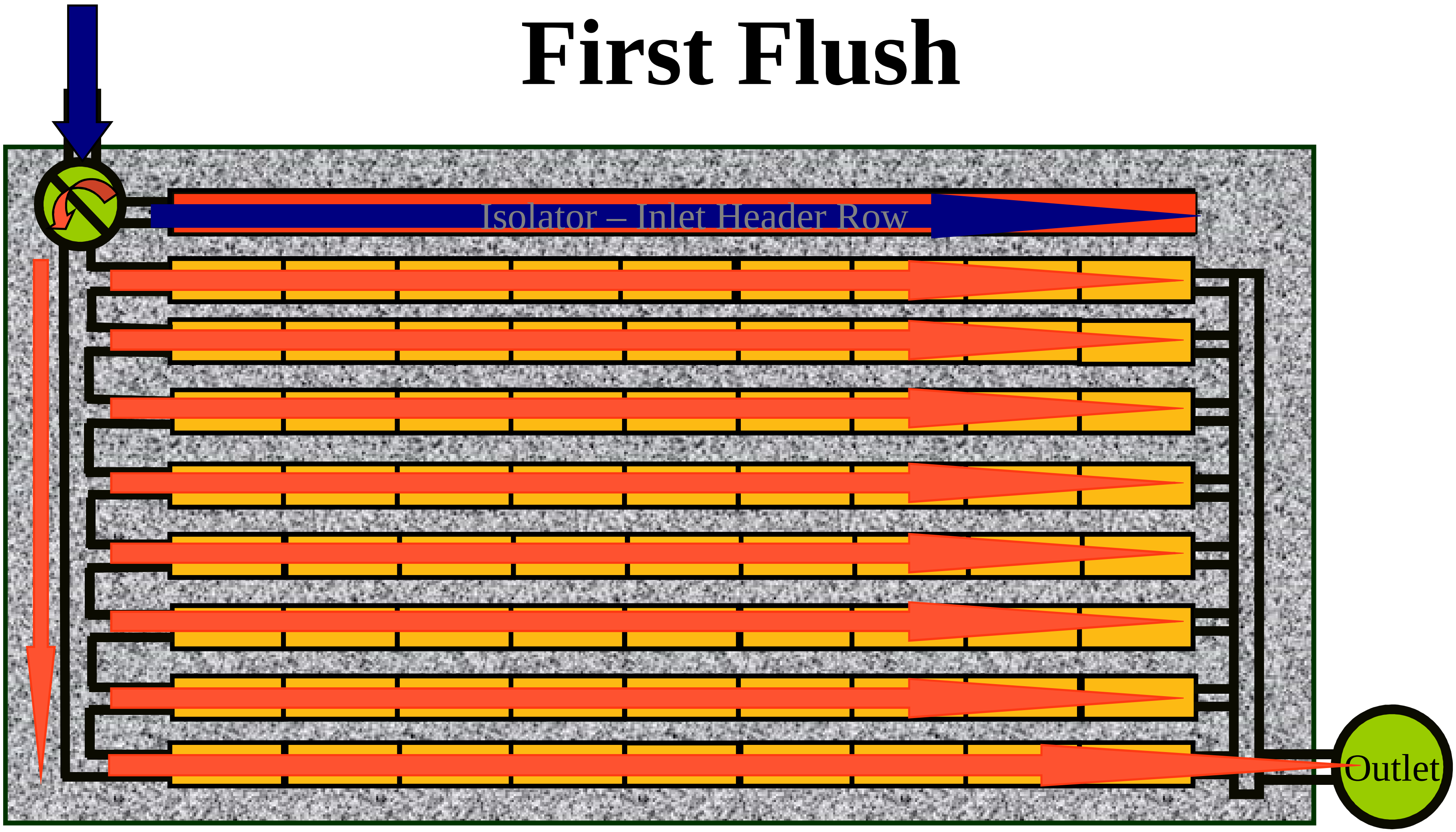


Max/Min Covers



Water Quality Expectations

First Flush



Water Quality Expectations

Non-woven fabric on top

Woven fabric on bottom

Water Quality Expectations

- February 23, 2005 - Tennessee Tech University summarized laboratory testing on the Isolator Row in accordance with Maine DEP testing protocol. Tests demonstrated the following:
  - 95% TSS overall removal at 8.1 gpm/sqft for US Silica OK-110 (110 micron).
  - 80% captured on fabric.

- October 20, 2006 - Tennessee Tech University summarized laboratory testing on the Isolator Row in accordance with New Jersey Center for Advanced Technologies (NJCAT) testing protocol. Tests demonstrated the following:
  - 60% TSS Removal at 3.2 gpm/sqft for Sil-Co-Sil 106 with accumulated fines (D_{50} = 10 microns)
  - 66% TSS Removal at 3.2 gpm/sqft for Sil-Co-Sil 106 (D_{50} = 22 microns)
  - 71% TSS Removal at 3.2 gpm/sqft for Sil-Co-Sil 250 (D_{50} = 45 microns)
  - 88% TSS Removal at 1.7 gpm/sqft for Sil-Co-Sil 250 (D_{50} = 45 microns)

- August, 2007 – NJCAT summarized its third party evaluation of the Tennessee Tech test results and produced the "NJCAT Technology Verification Report StormTech Isolator Row". Their verification is summarized as follows:

  - **Claim 1:** A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of at least 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

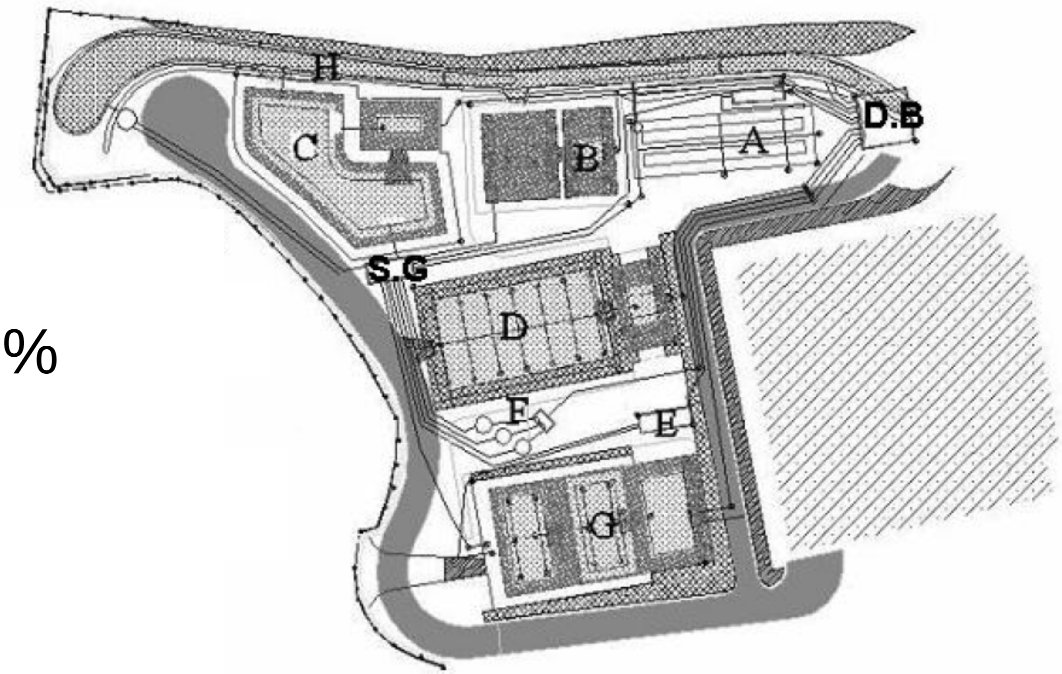
  - **Claim 2:** A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

Water Quality Expectations

- **Claim 3:** A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

Water Quality Expectations

- TSS – 80%
- Hydrocarbons – 90%
- Zinc– 53%
- Phosphorus– 49%



June 2008 – The University of New Hampshire Stormwater Center Field Test

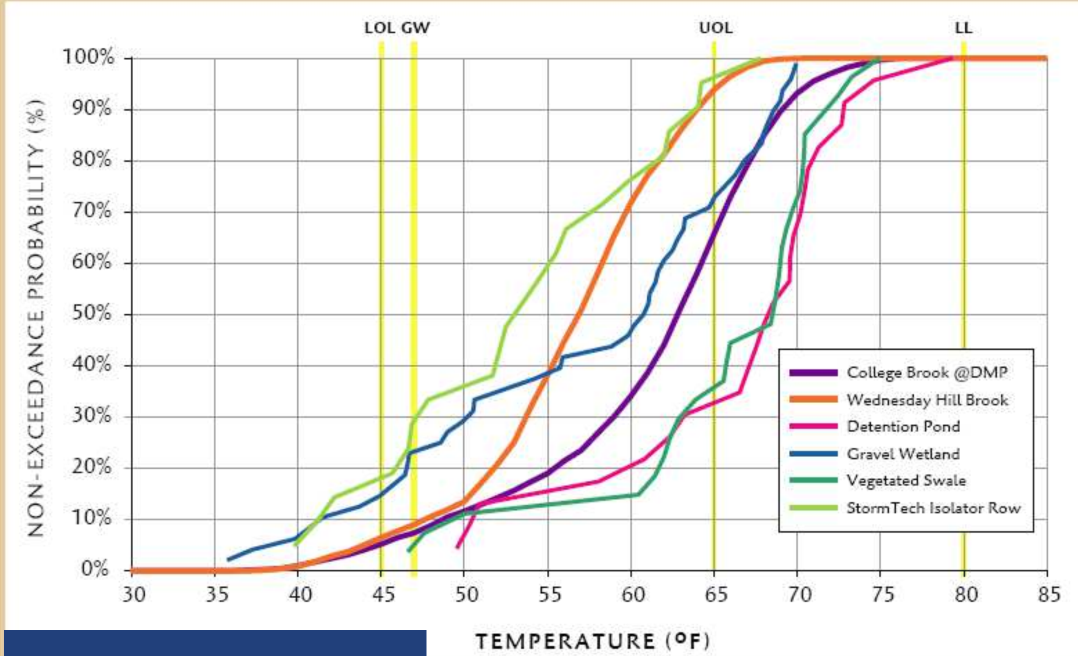
Water Quality Expectations

Filtration and infiltration systems **showed the strongest ability to reduce temperature variations.** The gravel wetland, the ADS (Advanced Drainage Systems™) Infiltration System, and the StormTech Isolator Row have a strong capacity to reduce temperatures of runoff.

The two subsurface infiltration systems, ADS and STIR, are the only systems with mean July temperatures within the optimum zone of 45°F to 65°F for coldwater aquatic species. All other systems result in runoff within the stress zone for aquatic species, between 65°F and 80°F.

The Gravel Wetland, the ADS infiltration system, and the Isolator Row systems have the lowest exceedance values of the UOL at 13.0%, 5.0%, 1.5% respectively.

Water Quality Expectations



Comparison of summer temperatures for two streams: Wednesday Hill Brook (unimpacted) and College Brook (impacted); a wet and dry pond, a gravel wetland, and subsurface infiltration (Stormtech Isolator Row) with environmental indicators for cold water fisheries:

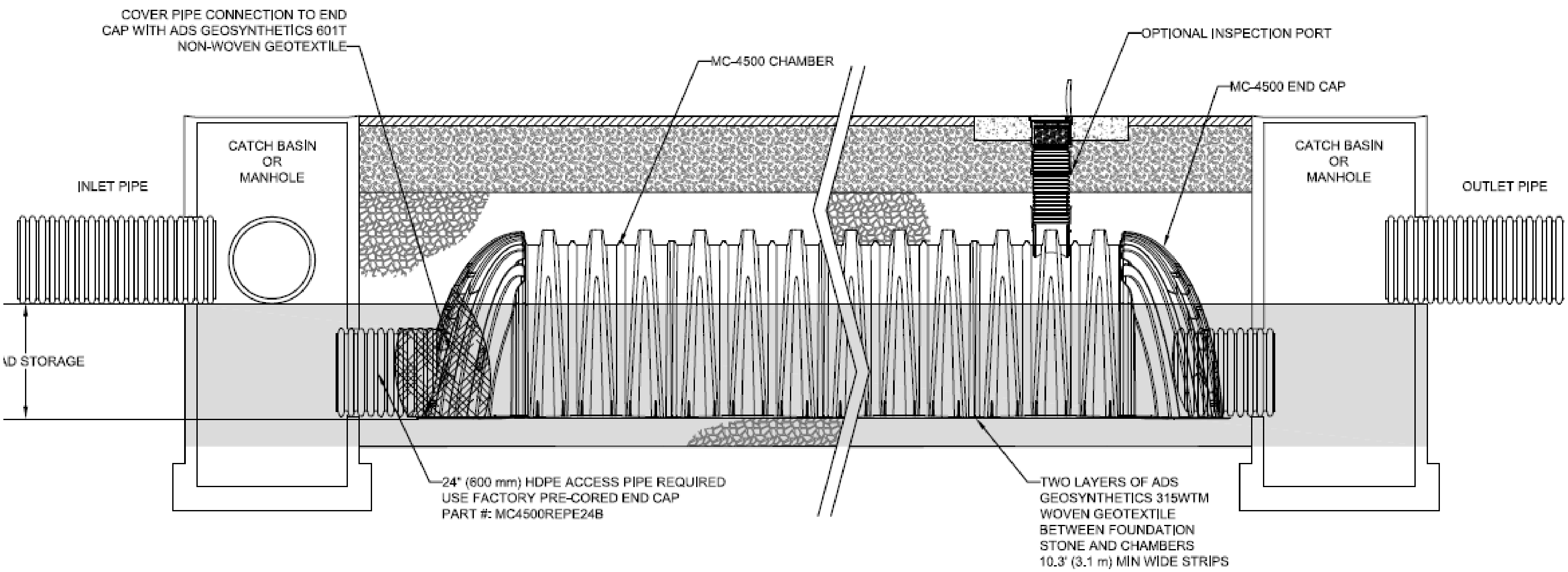
Average Annual Groundwater Temperature (GW) = 47°F

Lower Optimum Limit (LOL) = 45°F

Upper Optimum Limit (UOL) = 65°F

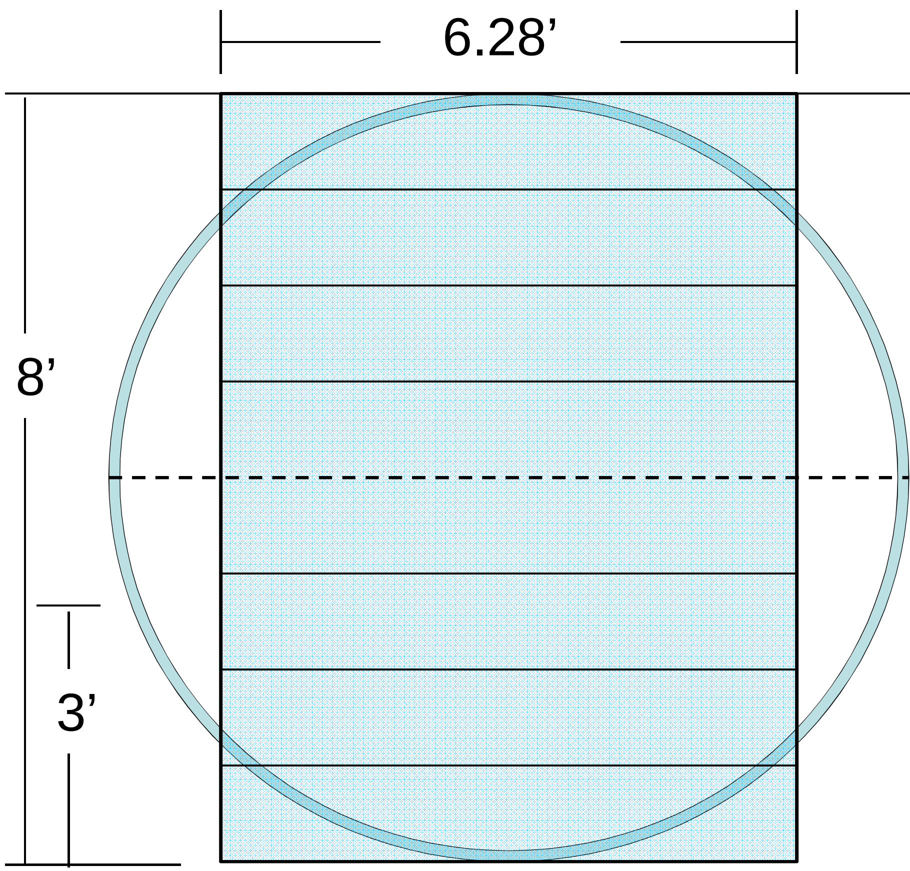
Lethal Limit (LL) = 80°F

Water Quality Expectations



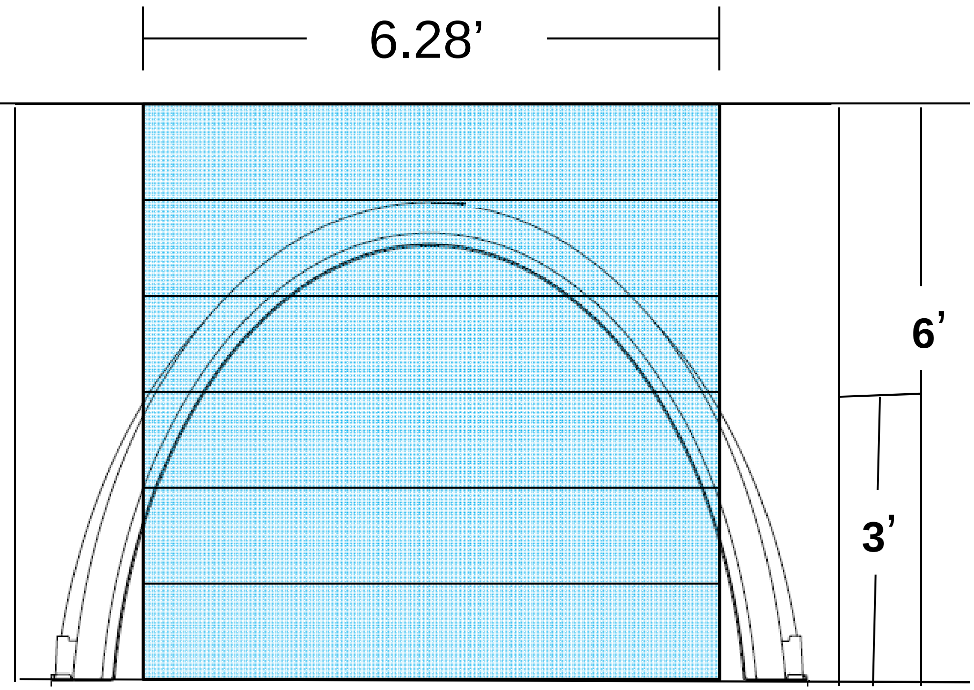
Modeling in WinSLAMM

Water Quality Expectations



96" CMP

50.26 CF/LF ÷8' = 6.283'

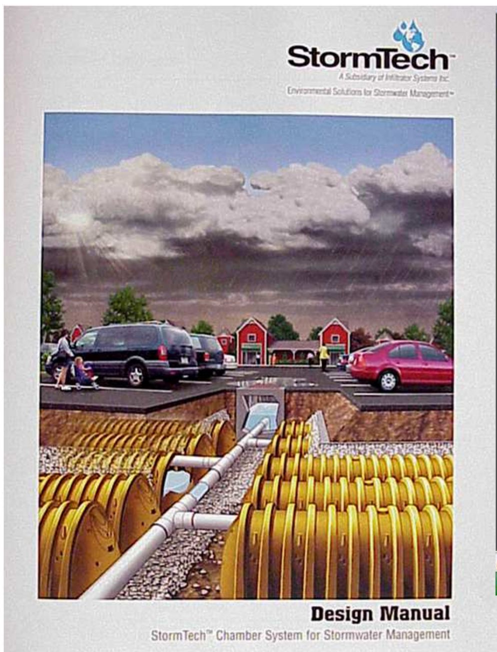


MC4500

37.68 CF/LF ÷6' = 6.28

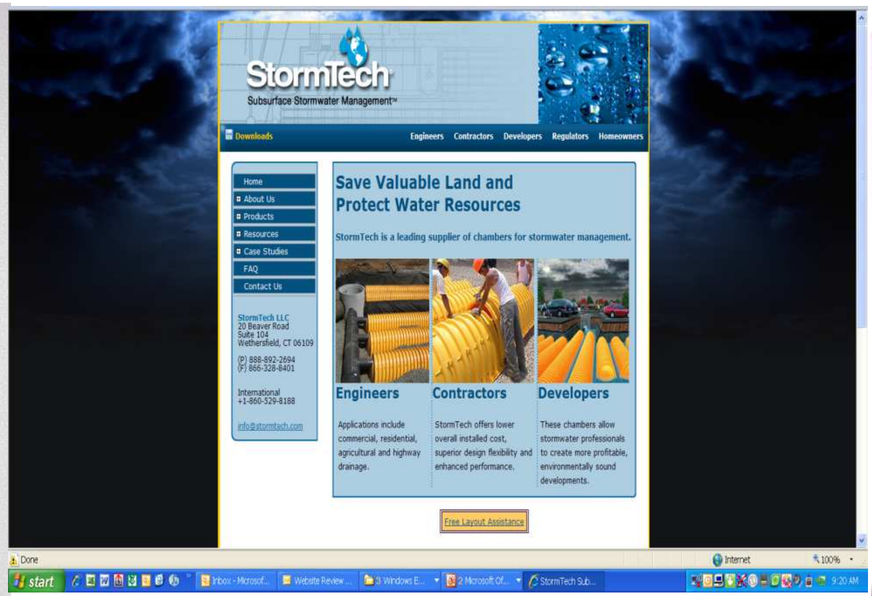
Support Materials

Design Manual

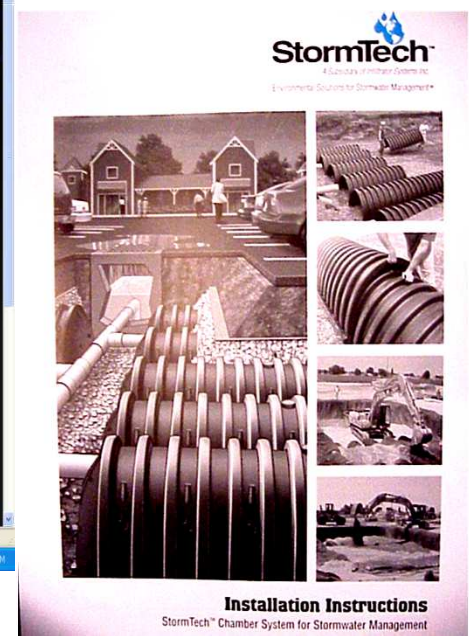


Web Site

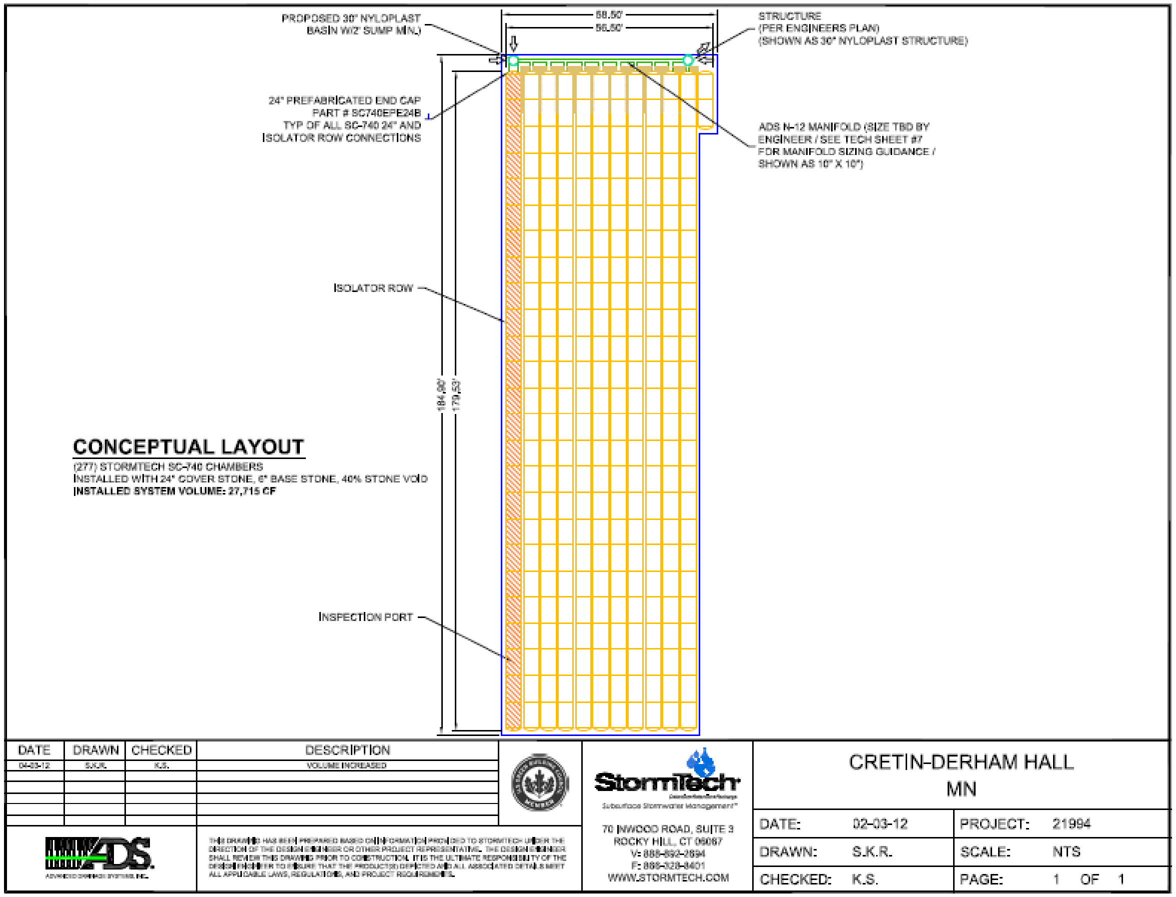
NEW 11/10/08

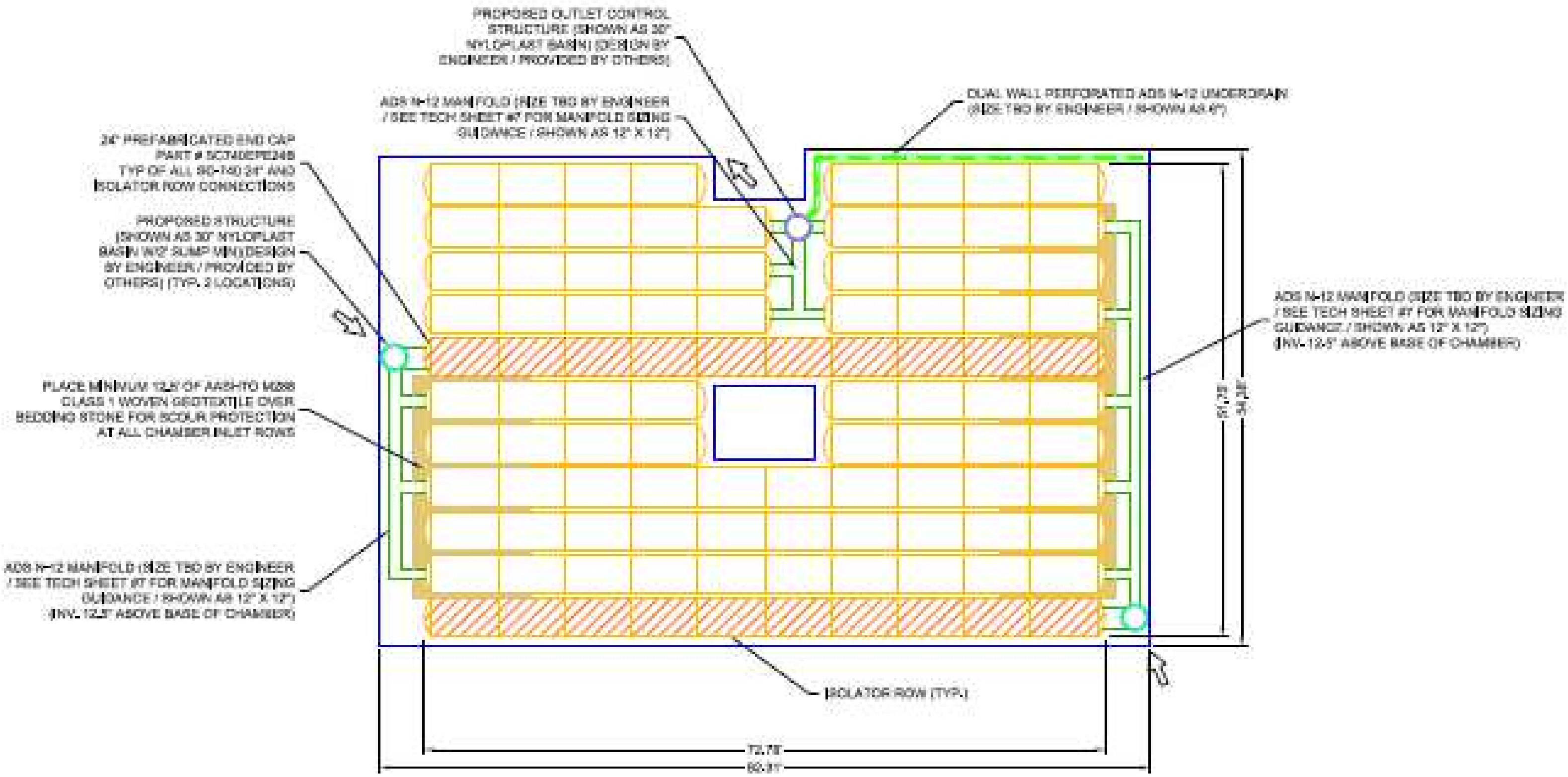


Installation Instructions



Cretin Durham Hall – St. Paul





PROPOSED ELEVATIONS

MAX. GRADE (TOP OF PAVEMENT/UNPAVED):	915.30
MIN. GRADE (UNPAVED WITH TRAFFIC):	909.30
MIN. GRADE (BASE OF FLEXIBLE PAVEMENT/UNPAVED):	908.30
MIN. GRADE (TOP OF REINFORCED CONCRETE PAVEMENT):	908.80
TOP OF STONE:	907.80
TOP OF CHAMBER:	907.30
12" TOP FEEDING MANIFOLD INVERT:	905.84
12" BOTTOM FEEDING MANIFOLD INVERT:	904.30
24" INVERT TO ISOLATOR ROW(S):	904.81
BOTTOM OF CHAMBER:	904.80
BOTTOM OF STONE:	904.30
UNDERDRAIN:	904.30

CONCEPTUAL LAYOUT

(101) STORMTECH SC-740 CHAMBERS
INSTALLED WITH 6" COVER STONE, 6" BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME (PERIMETER STONE INCLUDED) = 7,983 CF
(6" COVER STONE NOT INCLUDED IN VOLUME AMOUNT)

DATE	DRAWN	CHECKED	DESCRIPTION
11-02-12	S.K.R.	K.S.	RELOCATED CHAMBERS DUE TO LIGHT POLE

ADVANCED DRAINAGE SYSTEMS, INC.

THIS DRAWING HAS BEEN PREPARED BASED ON INFORMATION PROVIDED TO STORMTECH UNDER THE DIRECTION OF THE DESIGN ENGINEER OR OTHER PROJECT REPRESENTATIVE. THE DESIGN ENGINEER SHALL REVIEW THIS DRAWING PRIOR TO CONSTRUCTION. IT IS THE ULTIMATE RESPONSIBILITY OF THE DESIGN ENGINEER TO ENSURE THAT THE PRODUCT(S) DEPICTED AND ALL ASSOCIATED DETAILS MEET ALL APPLICABLE LAWS, REGULATIONS, AND PROJECT REQUIREMENTS.

StormTech
Subsurface Stormwater Management

70 INWOOD ROAD, SUITE 3
ROCKY HILL, CT 06067
V: 888-892-2694
F: 866-328-8401
WWW.STORMTECH.COM

KNOLLWOOD CROSSINGS
MN

DATE:	09-20-12	PROJECT:	29626
DRAWN:	S.K.R.	SCALE:	NTS
CHECKED:	K.S.	PAGE:	1 OF 1

Knollwood Crossing, St. Louis Park

Dock Street Apartments, Minneapolis

Dock St. Apartments, Minneapolis

StormTech® Detention • Retention • Water Quality
Division of ADS

NOTES FOR INSTALLATION OF MC-3500 CHAMBER SYSTEM:

1. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
2. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
3. MAINTAIN MINIMUM - 9" SPACING BETWEEN THE CHAMBER ROWS.
4. END CAPS SHALL BE FASTENED TO CHAMBERS WITH (3) 2-1/2" COURSE THREAD SCREWS.
5. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM 12" INTO CHAMBER END CAPS.
6. EMBEDMENT STONE SURROUDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4"-2" MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4

CONTACT STORMTECH:

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

NOTES FOR CONSTRUCTION EQUIPMENT:

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   A. NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS
   B. NO RUBBER TIRED LOADER, DUMP TRUCKS, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
   C. WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
3. STONE MUST BE PLACED EVENLY ON BOTH SIDES OF CHAMBERS TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING AND ALIGNMENT.
4. STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTH SHOULD NEVER DIFFER BY MORE THAN 12" BETWEEN ADJACENT CHAMBER ROWS.
5. DUMP TRUCKS OR LOADERS SHALL NOT DUMP STONE DIRECTLY ON THE BED.

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

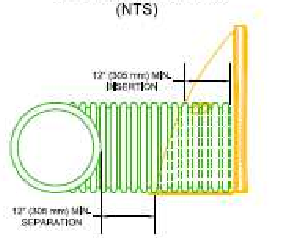
PROPOSED ELEVATIONS

MAX. GRADE (TOP OF PAVEMENT/UNPAVED):	830.80
MIN. GRADE (UNPAVED WITH TRAFFIC):	826.80
MIN. GRADE (BASE OF FLEXIBLE PAVEMENT/UNPAVED):	826.30
MIN. GRADE (TOP OF REINFORCED CONCRETE PAVEMENT):	826.30
TOP OF STONE:	825.30
TOP OF CHAMBER:	824.30
12" TOP FEEDING MANIFOLD INVERT:	822.75
15" TOP MANIFOLD INVERT:	822.50
24" INVERT TO ISOLATOR ROW(S):	820.72
12" BOTTOM FEEDING MANIFOLD INVERT:	820.66
BOTTOM OF CHAMBER:	820.55
BOTTOM OF STONE:	819.80

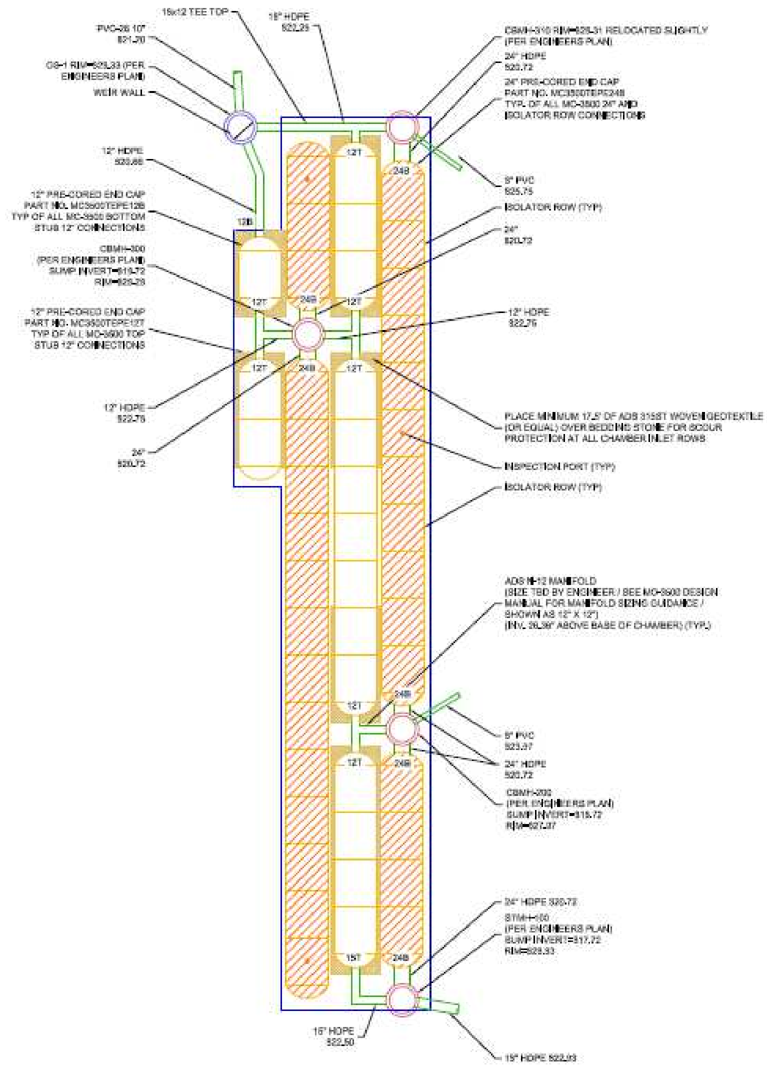
PROPOSED LAYOUT

(48) STORMTECH MC-3500 CHAMBERS
(18) STORMTECH MC-3500 END CAPS
INSTALLED WITH 12" COVER STONE, 9" BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME (PERIMETER STONE INCLUDED): 10,718 CF

MC-3500 MANIFOLD INSERTION & SEPARATION DETAIL
(NTS)



NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN THE END CAP OPENING.



DATE	DRN	CHK	DESCRIPTION

THE DOCK ST APTS, MINNEAPOLIS, MN

DATE:	11-8-12	PROJECT #:	21383
DRAWN BY:	JTL	SCALE:	NTS
CHECKED BY:		PAGE:	1 OF 5

StormTech® Subsurface Stormwater Management

ADS ADVANCED DRAINAGE SYSTEMS, INC.

Schmidt Brewery Lofts, St. Paul

Schmidt Brewery Lofts, St. Paul

Chick-fil-A, Bloomington

Scenic Heights Elementary, Deephaven

Calhoun Greenway
Minneapolis

Walmart, Roseville

Walmart, Roseville

StormTech®
Detention • Retention • Water Quality
Division of ADS

Walmart, Roseville

Byerly's, Edina

Hansen Center, Duluth

Pequot Lakes High School

Knollwood Crossing

Dock St. Apartments, Minneapolis

StormTech® Detention • Retention • Water Quality
Division of ADS

NOTES FOR INSTALLATION OF MC-3500 CHAMBER SYSTEM:

1. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
2. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
3. MAINTAIN MINIMUM - 9" SPACING BETWEEN THE CHAMBER ROWS.
4. END CAPS SHALL BE FASTENED TO CHAMBERS WITH (3) 2-1/2" COURSE THREAD SCREWS.
5. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM 12" INTO CHAMBER END CAPS.
6. EMBEDMENT STONE SURROUDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4"-2" MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4

CONTACT STORMTECH:

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

NOTES FOR CONSTRUCTION EQUIPMENT:

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   - A. NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS
   - B. NO RUBBER TIRED LOADER, DUMP TRUCKS, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
   - C. WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE MC-3500/MC-4500 STORMTECH CONSTRUCTION GUIDE.
3. STONE MUST BE PLACED EVENLY ON BOTH SIDES OF CHAMBERS TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING AND ALIGNMENT.
4. STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTH SHOULD NEVER DIFFER BY MORE THAN 12" BETWEEN ADJACENT CHAMBER ROWS.
5. DUMP TRUCKS OR LOADERS SHALL NOT DUMP STONE DIRECTLY ON THE BED.

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

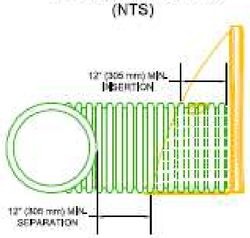
PROPOSED ELEVATIONS

MAX. GRADE (TOP OF PAVEMENT/UNPAVED):	830.80
MIN. GRADE (UNPAVED WITH TRAFFIC):	825.80
MIN. GRADE (BASE OF FLEXIBLE PAVEMENT/UNPAVED):	826.30
MIN. GRADE (TOP OF REINFORCED CONCRETE PAVEMENT):	826.30
TOP OF STONE:	825.30
TOP OF CHAMBER:	824.30
12" TOP FEEDING MANIFOLD INVERT:	822.75
15" TOP MANIFOLD INVERT:	822.50
24" INVERT TO ISOLATOR ROW(S):	820.72
12" BOTTOM FEEDING MANIFOLD INVERT:	820.66
BOTTOM OF CHAMBER:	820.55
BOTTOM OF STONE:	819.80

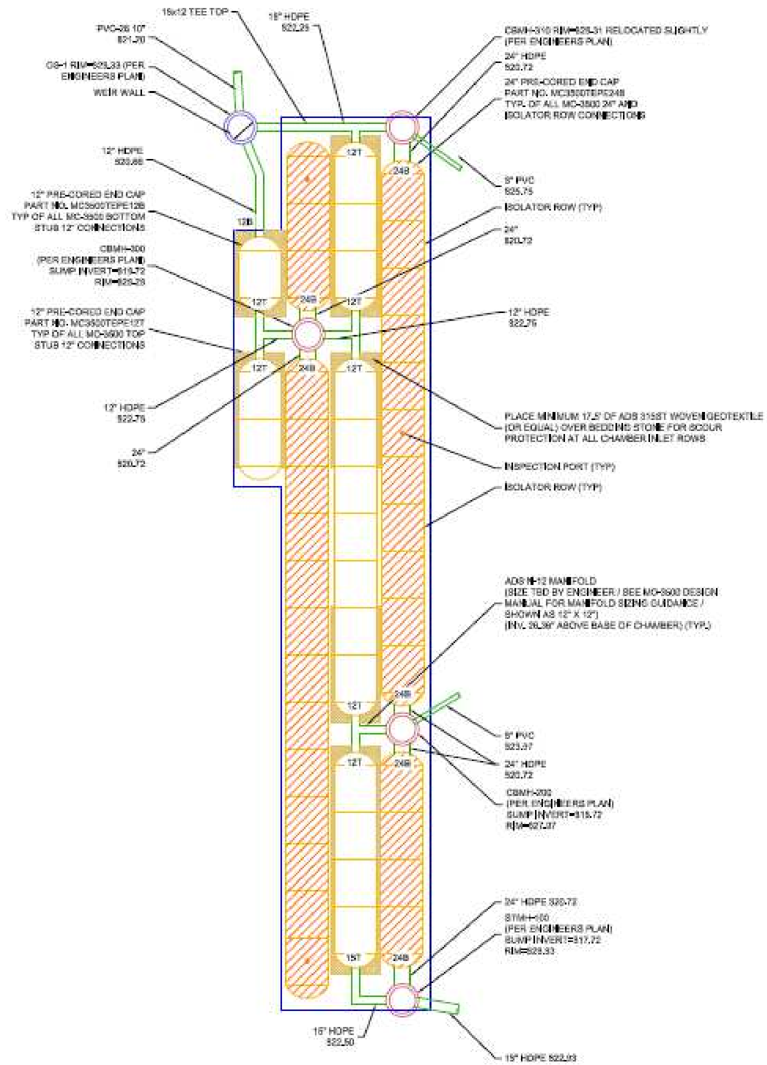
PROPOSED LAYOUT

(48) STORMTECH MC-3500 CHAMBERS
(18) STORMTECH MC-3500 END CAPS
INSTALLED WITH 12" COVER STONE, 9" BASE STONE, 40% STONE VOID
INSTALLED SYSTEM VOLUME (PERIMETER STONE INCLUDED): 10,718 CF

MC-3500 MANIFOLD INSERTION & SEPARATION DETAIL
(NTS)



NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN THE END CAP OPENING.



THE DOCK ST APTS. MINNEAPOLIS, MN

DATE: 11-6-12	PROJECT #: 21383
DRAWN BY: JTL	SCALE: NTS
CHECKED BY:	PAGE: 1 OF 5

StormTech®
Detention • Retention • Water Quality
Division of ADS

20 minutes of video in one minute….how to install chambers….quickly!

StormTech®
Detention • Retention • Water Quality
Division of ADS

Mark A. Scholle, P.E.
Regional Engineer/ Products Manager MN, WI, ND
(612) 296-7692
mark.scholle@ads-pipe.com

Stacked (Multi-layer)Chamber Systems

- ***Can it be done if constructed correctly?***
  - *ST spent resources 8 years ago modeling the multi-layer system. Due to confirmed difficulty in field installation and potential loss of safety factors we decided to not offer stacked system designs. StormTech decided to invest in larger injection molded chambers. that meet the same industry performance standards of our smaller chambers.*
- ***Constructability and Performance Standards Matter***
  - *Multi-Layered Chambers Systems have failed and in most cases the failure mode is blamed on the contractor. Safety factors are compromised when multi-layer systems are installed in the field. This type of design is not included in ASTM 2787.*
  - *There is no consistent aggregate thickness separation between rows and some manufacturers even use geo-grids to prevent the layers from settling into the layer beneath. Distortion of chambers and inconsistencies in the stone support in the lower layers may result in insufficient structural capacity to support the upper layers.*
  - *Engineers who choose to design projects with multi-layers may be unknowingly increasing their potential liability because there are no industry design standards that recognize the practice of stacking chambers.*

Stacked (Multi-layer)Chamber Systems

- ***The absence of an Industry Performance Standard with safety factors***
  - The only Chamber Design Standard (ASTM F2787) "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" does not include a design methodology for stacked systems.
  - At least one other major manufacturer of chambers meets ASTM F2787 and AASHTO Section 12.12 of the LRFD Bridge Design Specifications standards and like StormTech they do not recommend multi-layered chamber designs.
  - Companies that have offered "stacked" designs may state that these systems are "H20 or H25" rated" **There is no nationally recognized third party "H20 or H25 rating."** Engineers and owners should be aware that H20 or H25 is only a wheel load. AASHTO prescribes a complete design methodology where structures must be evaluated for both short term and long term adequacy (safety factors of 1.95 for long term dead load and 1.75 for live load) for numerous potential failure states. AASHTO uses the "Design Truck," "Design Tandem" or the "H20 or H25" design vehicle as the starting point for a live load calculation. "H20 or H25" is not a rating it is potentially a misleading misnomer.

Questions please contact:

Mark A. Scholle, P.E.
Engineered Products Manager
(612) 296-7692
mark.scholle@ads-pipe.com

www.ads-pipe.com

Questions please contact:

Mark A. Scholle, P.E. **Engineered Products Manager** (612) 296-7692 mark.scholle@ads-pipe.com	**Matt Baragary** **TC’s & SE Minnesota** (612) 756-3552 Matt.baragary@ads-pipe.com

www.ads-pipe.com

StormTech®
Detention • Retention • Water Quality
Division of ADS

SaniTite® HP
HIGH PERFORMANCE

Questions please contact:

Mark A. Scholle, P.E. **Engineered Products Manager** (612) 296-7692 mark.scholle@ads-pipe.com	**Paul Scheid** **TC's & NE Minnesota** (612) 756-3552 Paul.Scheid@ads-pipe.com

www.ads-pipe.com

Questions please contact:

Mark A. Scholle, P.E. **Engineered Products Manager** (612) 296-7692 mark.scholle@ads-pipe.com	**Matt Baragary** **Twin Cities / Rochester** (612) 756-9552 matt.baragary@ads-pipe.com

www.ads-pipe.com

Questions please contact:

Mark A. Scholle, P.E. **Engineered Products Manager** (612) 296-7692 mark.scholle@ads-pipe.com	**Chuck Dodge** **Milwaukee** (262) 483-0606 Chuck.dodge@ads-pipe.com

www.ads-pipe.com

Questions please contact:

Mark A. Scholle, P.E. **Engineered Products Manager** (612) 296-7692 mark.scholle@ads-pipe.com	**Karl Guetter** **SW Minnesota** (507) 828-8513 karl.guetter@ads-pipe.com

www.ads-pipe.com