Merrill
Engineers and Land Surveyors

April 30, 2021

Long-Term Pollution Prevention Plan
Operation & Maintenance Plan

#15, 19, 27 & 35 High Street, Norwell

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LONG TERM POLLUTION PREVENTION PLAN / OPERATION AND MAINTENANCE PLAN

Date: April 30, 2021

15 High Street
Proposed Residential Development
15, 19, 27 & 35 High Street
Norwell, MA

Responsible Party for Operation and Maintenance Contact Information:

Northland Residential Corporation
80 Beharrell Street, Suite E
Concord, Massachusetts 01742
P: 781.229.4700

Best Management Practices (BMPs) of the Commonwealth of Massachusetts Department of Environmental Protection's (DEP's) Stormwater Management Policy (SMP) have been implemented and utilized for the project. The following information provided is to be used as a guideline for monitoring and maintaining the performance of the drainage facilities and to ensure that the quality of water runoff meets the standards set forth by the SMP. The structural Best Management Practices (BMPs) shall be inspected during rainfall conditions during the first year of operation to verify functionality.

General Conditions

1. The BMP's will be owned and maintained by the property owner.
2. All Stormwater BMP's shall be operated and maintained in accordance with the design plans and the following Long-Term Operations and Maintenance Plan.
3. The Responsible Party shall:
    a. Maintain an Operation and Maintenance Log (see Attachment A). The Log shall include all BMP inspections, repairs, replacement activities and disposal activities (disposal material and disposal location shall be included in the Log);
    b. Retain inspection and maintenance logs for a period of three years, on an ongoing basis;
    c. Make the logs available to the Town upon request;
    d. Allow members and agents of the Norwell DPW to enter the premises and ensure that the Responsible Party has complied with the Operation and Maintenance Plan requirements for each BMP.
4. An inspection and maintenance schedule should be adhered to at a minimum for the first year of service of all BMP's referenced in this document. After the first year of service, a more accurate inspection/maintenance schedule should be determined based on the level of service for this site.

Operation and Maintenance

1.0 Requirements for Routine Inspections and Maintenance of Stormwater Best Management Practices

Note: The Town shall be notified immediately if a change in ownership or maintenance responsibility occurs at the site.

Drain lines

After construction, the drainlines shall be inspected after every major storm for the first few months to ensure proper functions. Presence of accumulated sand and silt would indicate more frequent maintenance of the pre-treatment devices is required. Thereafter, the drainlines shall be inspected at least once per year.

Deep sump and hooded Catch Basins

Catch basin grates shall be checked quarterly and following heavy rainfalls to verify that the inlet openings are not clogged by debris. Debris shall be removed from the grates and disposed of properly. Deep sump catch basins shall be inspected and cleaned bi-annually of all accumulated sediments. Catch basins with hoods shall be inspected annually to check oil build-up and outlet obstructions. Material shall be removed from catch basins and disposed of in accordance with all applicable regulations.

Pre-treatment Structures – First Defense FD-6HC

The proprietary pretreatment unit shall be inspected and maintained from the surface, without entry into the unit biannually and following heavy rain events defined as a storm event exceeding one inch of rainfall within a twenty-four hour period to verify that the inlet opening is not clogged by debris.

During the first year of installation, perform inspection regularly, so an accurate maintenance schedule can be established. Perform oil and floatables removal once per year and immediately in the event of a spill. Oil shall be removed by using a small portable pump and disposed of properly. Perform sediment removal once per year or as needed and following a spill event. Sediment shall be removed from the unit using a vacuum truck. The requirements for the disposal from the unit should be in compliance with all local, state and federal regulations.

Please refer to the attached manufacturer's maintenance manual for additional detail on proper inspection and maintenance of the First Defense unit.

Subsurface Infiltration Chamber System

Proper maintenance of the subsurface infiltration system is essential to the long-term effectiveness of the infiltration function. After construction, the subsurface infiltration chamber systems shall be inspected for proper function after every major storm event until the site is completely developed and stabilized. After the site has been stabilized, the subsurface infiltration chamber system shall be inspected at least twice per year or if lack of performance is observed and perform necessary corrective measures to maintain infiltration capacity; as required by the Stormwater Management Policy.

The system shall have inspection ports for proper inspections. Inspections shall include checking the water level in the system after a major storm event, and performing necessary corrective action if water is observed 72 hours following the storm. The owner shall retain a qualified stormwater professional to assess the cause of this condition and develop a corrective action plan for restoring the infiltration function. The owner shall immediately implement the corrective action to restore the infiltration function. Documentation of these actions shall be maintained in the inspection and maintenance records.

Inspection & Maintenance Steps

Accumulated sediment must be removed from the bottom of the chambers. Material removed from the systems shall be disposed of in accordance with all applicable local, state, and federal regulations.

Step 1. Inspect chamber rows for sediment and water levels

7.0 Inspection Ports

a. Remove/open lid on nyloplast inspection port
b. Remove and clean flexstorm filter if installed
c. Using a flashlight and stadia rod, measure depth of sediment or water level and record on maintenance log
d. Lower camera into chamber row for visual inspection of sediment or water levels (optional)
e. If water is observed 72 hours following a storm event, proceed to Step 3. If not, proceed to Step 4

8.0 Clean out locations

8.1 Remove clean out cover

8.2 Using a flashlight, inspect down the chamber row through the manifold pipe

8.3 If sediment is at, or above 3" at inlet chambers, proceed to Step 2. If not, proceed to Step 4.

Step 2. Clean out inlet chambers (first 12.5 ft. only) using the jetvac process if sediment build up is observed

a. A fixed culvert cleaning nozzle with rear facing spread of 45" or more is preferred
b. Apply multiple passes of jetvac until backflush water is clean
c. Vacuum structure sump as required

Step 3. Repair chamber system when water levels do not infiltrate after 72 hours. A corrective action plan shall be prepared by a qualified stormwater professional and immediately implemented.

Step 4. Replace all covers, grates, filters, and lids; record observations and actions.

Step 5. Inspect and clean basins and manholes upstream of the chamber system.

Please refer to the attached manufacturer's maintenance manual for additional detail on proper inspection and maintenance of the StormTech chamber system.

Roadway Pavement Maintenance

Vacuum sweepers shall sweep the roadway periodically during dry weather to remove excess sediments to reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping should be conducted four times per year and will be the responsibility of the property owner.

Salt used for de-icing on the roadway during winter months should be limited as much as possible as this will reduce the need for removal and treatment.

Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

2.0 Inspections

The responsible party shall secure the services of a Licensed Engineer or similar professional (inspector) on an on-going basis. The inspector shall review the project with respect to the following:

- Proper installation and performance of the Stormwater Management System.
- Review of the controls to determine any damaged or ineffective controls.
- Corrective actions.

The inspector shall prepare a report documenting the findings and should request the required maintenance or repair for the pollution prevention controls when the inspector finds that it is necessary for the control to be effective.

If hydrocarbons or any petroleum products are detected in any stormwater structure during an inspection, immediate measures shall be taken to remove and dispose of the material in accordance with all applicable regulations. The inspector shall notify the Owner to make the changes.

The owner shall be responsible for retaining the inspection and maintenance records for a period of three years, on an ongoing basis.

For additional information, refer to Performance, Standards and Guidelines for Stormwater Management in Massachusetts, published by the Department of Environmental Protection.

Pollution Prevention Plan

Good Housekeeping

To develop and implement an operation and maintenance program with the goal of preventing or reducing pollutant runoff by keeping potential pollutants from coming into

contact with stormwater or being transported off site without treatment, the following efforts will be made:

- Property Management awareness and training on how to incorporate pollution prevention techniques into maintenance operations.
- Follow appropriate best management practices (BMPs) by proper maintenance and inspection procedures.
- Resident education outreach, including promoting recycling through the Town of Norwell Transfer Station.

1.0 <u>Storage and Disposal of Household Waste and Toxics</u>

This management measure involves educating the general public on the management considerations for hazardous materials. Failure to properly store hazardous materials dramatically increases the probability that they will end up in local waterways. Many people have hazardous chemicals stored throughout their homes, especially in garages and storage sheds. Practices such as covering hazardous materials or even storing them properly, can have dramatic impacts. Property owners are encouraged to support the household hazardous product collection events sponsored by the Town of Norwell.

MADEP has prepared several materials for residents on how to properly use and dispose of household hazardous materials:

http://www.mass.gov/dep/recycle/reduce/househol.htm

For consumer questions on household hazardous waste call the following number:

DEP Household Hazardous Waste Hotline 800-343-3420

The following is a list of management considerations for hazardous materials as outlined by the EPA:

- Ensuring sufficient aisle space to provide access for inspections and to improve the ease of material transport;
- Storing materials well away from high-traffic areas to reduce the likelihood of accidents that might cause spills or damage to drums, bags, or containers.
- Stacking containers in accordance with the manufacturers' directions to avoid damaging the container or the product itself;
- Storing containers on pallets or equivalent structures. This facilitates inspection for leaks and prevents the containers from coming into contact with wet floors, which can cause corrosion. This consideration also reduces the incidence of damage by pests.

The following is a list of commonly used hazardous materials used in the household:

Batteries – automotive and rechargeable Disinfectant

.....nickel cadmium batteries
.....(no alkaline batteries)
Gasoline
Oil-based paints
Fluorescent light bulbs and lamps
Pool chemicals
Propane tanks
Lawn chemicals,
fertilizers and weed killers
Turpentine
Bug sprays
Antifreeze
Paint thinners, strippers, varnishes and
..... stains
Arts and crafts chemicals
Charcoal lighter fluid
Drain clog dissolvers
Driveway sealer
Flea dips, sprays and collars
Houseplant insecticides
Metal polishes
Mothballs
Motor oil and filters
Muriatic acid (concrete cleaner)
Nail polishes and nail polish
removers
Oven cleaner
Household pest and rat poisons
Rug and upholstery cleaners
Shoe polish
Windshield wiper fluid

2.0 Vehicle Washing

This management measure involves educating the general public on the water quality impacts of the outdoor washing of automobiles and how to avoid allowing polluted runoff to enter the storm drain system. Outdoor car washing has the potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions in many watersheds, as the detergent-rich water used to wash the grime off our cars flows down the street and into the storm drain. The following management practices will be encouraged:

- Washing cars on gravel, grass, or other permeable surfaces.
- Blocking off the storm drain during car washing and redirecting wash water onto grass or landscaping to provide filtration.
- Using hoses with nozzles that automatically turn off when left unattended.
- Using only biodegradable soaps.
- Minimize the amounts of soap and water used. Wash cars less frequently.
- Promote use of commercial car wash services.

3.0 Landscape Maintenance

This management measure seeks to control the storm water impacts of landscaping and
lawn care practices through education and outreach on methods that reduce nutrient loadings and the amount of storm water runoff generated from lawns. Nutrient loads generated by fertilizer use on suburban lawns can be significant, and recent research has shown that lawns produce more surface runoff than previously thought.

Using proper landscaping techniques can effectively increase the value of a property while benefiting the environment. These practices can benefit the environment by reducing water use; decreasing energy use (because less water pumping and treatment is required); minimizing runoff of storm and irrigation water that transports soils, fertilizers, and pesticides; and creating additional habitat for plants and wildlife. The following lawn and landscaping management practices will be encouraged:

- Mow lawns at the highest recommended height.
- Minimize lawn size and maintain existing native vegetation.
- Collect rainwater for landscaping/gardening needs (rain barrels and cisterns to capture roof runoff).
- Raise public awareness for promoting the water efficient maintenance practices by informing users of water efficient irrigation techniques and other innovative approaches to water conservation.
- Abide by water restrictions and other conservation measures implemented by the Town of Norwell.
- Water only when necessary.
- Use automatic irrigation systems to reduce water use.

4. Integrated Pest Management (IPM)

This management measure seeks to limit the adverse impacts of insecticides and herbicides by providing information on alternative pest control techniques other than chemicals or explaining how to determine the correct dosages needed to manage pests.

The presence of pesticides in stormwater runoff has a direct impact on the health of aquatic organisms and can present a threat to humans through contamination of drinking water supplies. The pesticides of greatest concern are insecticides, such as diazinon and chlorpyrifos, which even at very low levels can be harmful to aquatic life. The major source of pesticides to urban steams is home application of products designed to kill insects and weeds in the lawn and garden.

The following IPM practices will be encouraged:

- Pesticides and herbicides shall be used sparingly. Fertilizers should be restricted to the use of organic fertilizers only.
- Lawn care and landscaping management programs including appropriate pesticide use management as part of program.

5. Pet Waste Management

Pet waste management involves using a combination of pet waste collection programs, pet awareness and education, to alert residents to the proper disposal techniques for pet droppings. The following management practices will be encouraged:

- Raise awareness of residents that are also pet owners that they are encouraged to pick up after their pets and dispose of the waste either in the trash, including on their own lawns and walking trails.
- Provide signage along walking trails.

6. Proper Management of Deicing Chemicals and Snow

The following deicing chemicals and snow storage practices will be encouraged:

- Select effective snow disposal sites adjacent to or on pervious surfaces in upland areas away from water resources and wells. At these locations, the snow meltwater can filter in to the soil, leaving behind sand and debris, which can be removed in the springtime.
- No roadway deicing materials shall be stockpiled on site unless all storage areas are protected from exposure to rain, snow, snowmelt and runoff.
- Avoid dumping snow into any waterbody, including wetlands, cranberry bogs, detention/infiltration basins, and grassed swales/channels.
- Avoid disposing of snow on top of storm drain catch basins.

7. Illicit Discharge Statement

Illicit discharges are non-stormwater discharges to the storm drain system which typically contain bacteria or other pollutants. All illicit discharges are prohibited. Any illicit discharges should be reported to MassDOT and/or the DPW as applicable to be addressed in accordance with their respective policies.

Allowable Non-Stormwater Discharges

The following non-stormwater discharges are authorized provided it has been determined by the permittee that they are not significant contributors of pollutants to the MS4. If these discharges are identified as significant contributors to the MS4, they must be addressed in the Illicit Discharge Detection and Elimination minimum control measure described in Parts II, III, IV and V.

1. water line flushing,
2. landscape irrigation,
3. diverted stream flows,
4. rising ground waters,
5. uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)),
6. uncontaminated pumped ground water,
7. discharge from potable water sources,
8. foundation drains,
9. air conditioning condensation,
10. irrigation water, springs,
11. water from crawl space pumps,
12. footing drains,
13. lawn watering,
14. flows from riparian habitats and wetlands,

15. dechlorinated swimming pool discharges,
16. street wash water, and
17. discharges or flows from fire fighting activities occur during emergency situations. The permittee is not expected to evaluate fire fighting discharges with regard to pollutant contributions. Therefore, these discharges are authorized as allowable non-storm water discharges, unless identified, by EPA, as significant sources of pollutants to Waters of the U.S..

Spill Containment and Management Plan

April 30, 2021

Initial Notification

In the event of a spill, the facility manager will be notified immediately.

Facility Managers (name) _____

_____

Facility Manager (phone) _____

Assessment - Initial Containment

The supervisor will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. The supervisor will first contact the Fire Department and then notify the Police Department, Department of Public Works, Board of Health and Conservation Commission. The fire department is ultimately responsible for matters of public health and safety and should be notified immediately.

Contact:	Phone Number:
Fire Department:	911
Police Department:	911
Department of Public Works:	(781) 659-8042
Board of Health Phone:	(781) 659-8016
Conservation Commission Phone:	(781) 659-8022

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the facility office and readily accessible to all employees.

HAZARDOUS WASTE / OIL SPILL REPORT

Date____/_____/_____ Time_____ AM / PM

Exact location (Transformer #)_____

Type of equipment_____ Make_____ Size_____

S / N_____ Weather Conditions_____

On or near water ☐ Yes ☐ No If yes, name of body of water_____

Type of chemical / oil spilled_____

Amount of chemical / oil spilled_____

Cause of spill_____

Measures taken to contain or clean up spill_____

Amount of chemical / oil recovered_____ Method_____

Material collected as a result of clean up

_____ drums containing_____

_____ drums containing_____

_____ drums containing_____

Location and method of debris disposal_____

Name and address of any person, firm, or corporation suffering damages_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring____

Spill reported to General Office by_____ Time_____ AM / PM

Spill reported to DEP / National Response Center by_____

DEP Date____/_____/_____ Time_____ AM / PM Inspector_____

NRC Date____/_____/_____ Time_____ AM / PM Inspector_____

Additional comments_____

EMERGENCY RESPONSE EQUIPMENT
INVENTORY

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

--	SORBENT PADS	1 BALE
--	SAND BAGS (empty)	5
--	SPEEDI-DRI ABSORBENT	1 – 40LB BAGS
--	12” INFLATABLE PIPE PLUG	1
--	15” INFLATABLE PIPE PLUG	1
--	18” INFLATABLE PIPE PLUG	1
--	SQUARE END SHOVELS	1
--	PRY BAR	1

EMERGENCY NOTIFICATION PHONE NUMBERS

1. FACILITY MANAGER
   NAME: _____ BEEPER: _____
   PHONE: _____ CELL PHONE: _____

   ALTERNATE:
   NAME: _____ BEEPER: N/A _____
   PHONE: _____ CEL PHONE: _____

2. FIRE DEPARTMENT
   EMERGENCY: 911
   BUSINESS: (781) 659-8158

3. POLICE DEPARTMENT
   EMERGENCY: 911
   BUSINESS: (781) 659-7979

4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
   EMERGENCY: (888) 340-1133
   SOUTHEAST REGION - LAKEVILLE OFFICE: (508) 946-2700

5. NATIONAL RESPONSE CENTER
   PHONE: (800) 424-8802

   ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY
   EMERGENCY: (617) 223-7265
   BUSINESS: (617) 860-4300

6. DEPARTMENT OF PUBLIC WORKS – ENGINEERING
   CONTACT: Glenn Ferguson, Director
   PHONE: (781) 659-8042

7. CONSERVATION COMMISSION
   CONTACT: Will Saunders, Conservation Agent
   PHONE: (781) 659-8022

8. BOARD OF HEALTH
   CONTACT: R. Benjamin Margro, Health Agent
   PHONE: (781) 659-8016

STORMWATER MANAGEMENT
BEST MANAGEMENT PRACTICES
INSPECTION SCHEDULE AND EVALUATION CHECKLIST – POST CONSTRUCTION PHASE

PROJECT LOCATION: **High Street, Norwell, MA** Latest Revision:_____

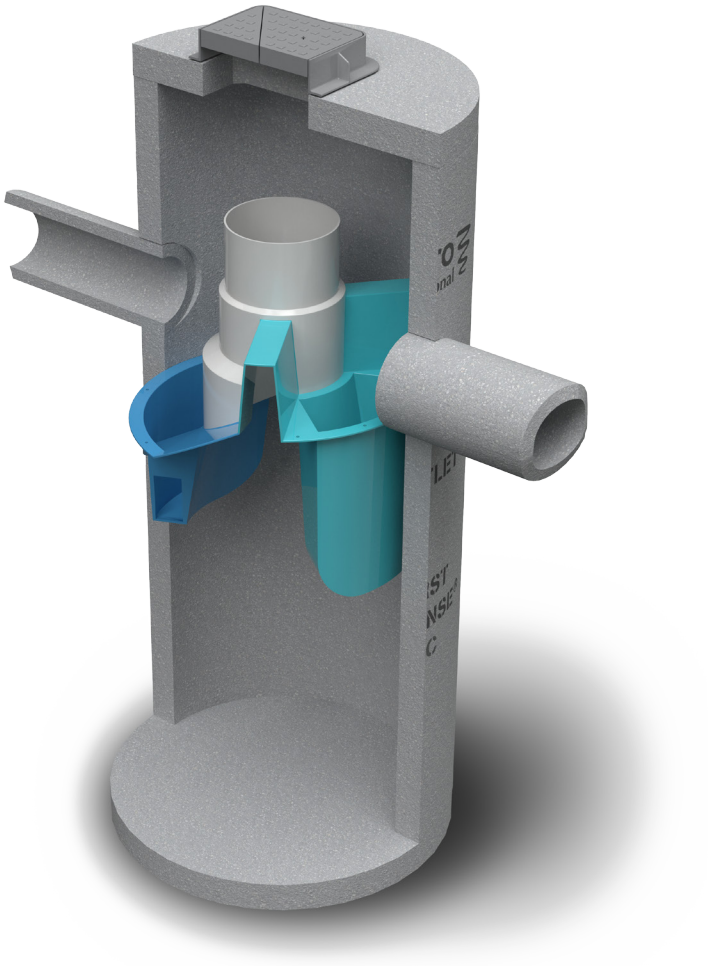
Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/Repair	Performed By	Water Level in Detention System
Drain Lines	Yearly			-Sediment build-up -Trash and debris				
Deep Sump Hooded Catch Basins	Quarterly			-Sediment level exceeds 8” -Trach and debris - Floatable oils or hydrocarbon - Grate or outlet blockage				
Pre-Treatment Structure (First Defense Unit)	Quarterly			-Sediment not to exceed 18” -Floating contaminates shall be removed by vacuum pump prior to sediment removal -Outlet blockages				
Subsurface Infiltration Chamber System	Twice a Year			-Sediment buildup -Standing water greater than 48 hours				
Roadway Pavement Maintenance	Quarterly							

(1) Refer to the Massachusetts Stormwater Management, Volume Two: Stormwater Technical Handbook (2008) for recommendations regarding frequency for inspection and maintenance of specific BMPs.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.
Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

Stormwater Control Manager: _____ **Stamp**

Hydro International



Operation and Maintenance Manual

First Defense® and First Defense® High Capacity

Vortex Separator for Stormwater Treatment

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I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for "offline" arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

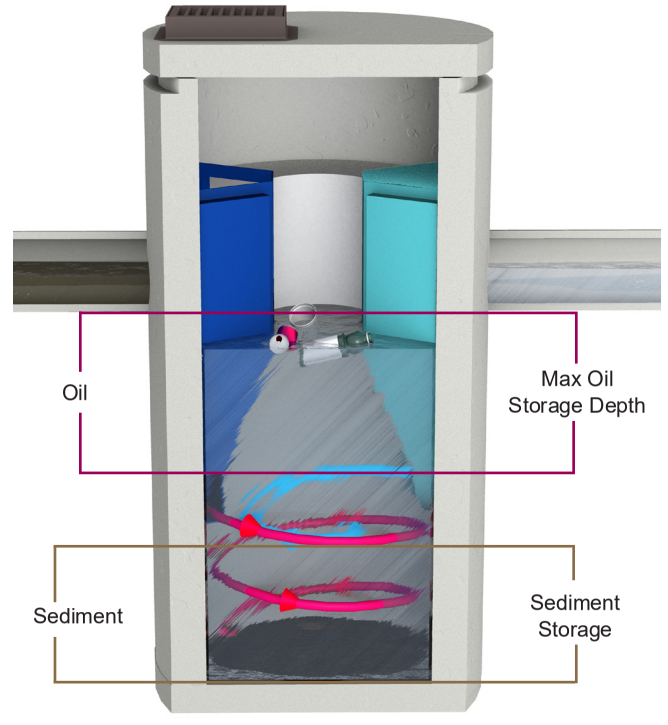


Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Sediment Storage**
8. **Inlet Grate or Cover**

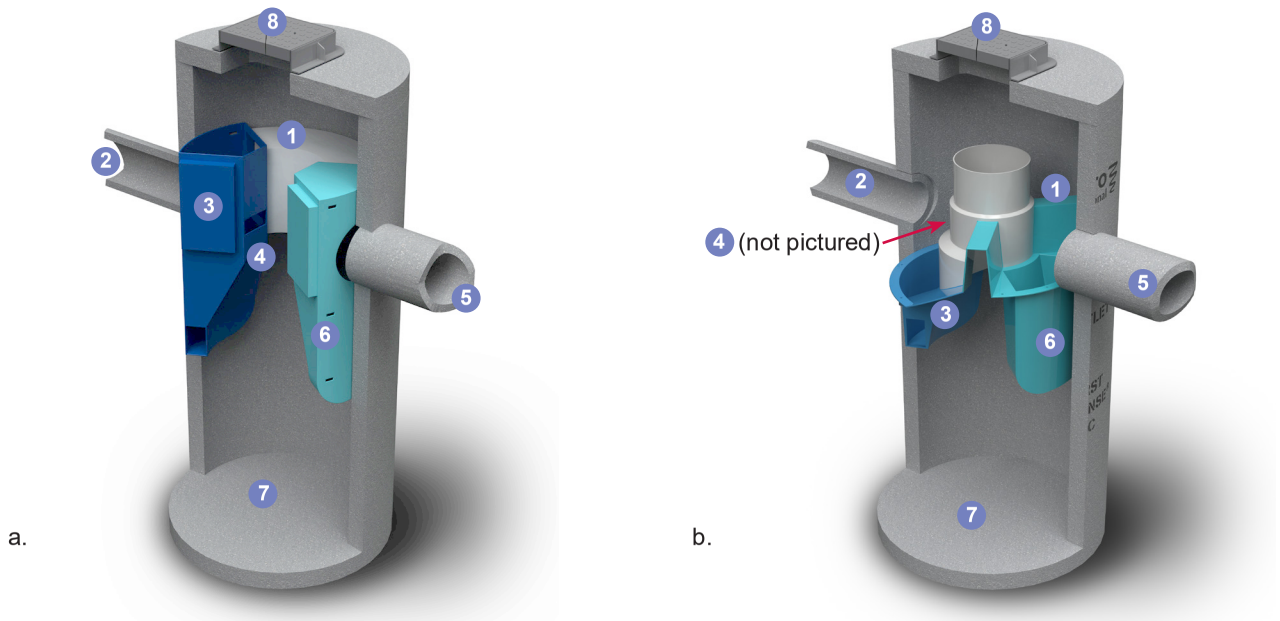


Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates NJDEP Certified	Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Chamber Depth
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.85 / 24.0	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.75 / 1.14
FD-4HC	4 / 1.2	1.50 / 42.4	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	5.00 / 1.52
FD-5HC	5 / 1.5	2.35 / 66.2	20 / 566	24 / 609	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.25 / 1.60
FD-6HC	6 / 1.8	3.38 / 95.7	32 / 906	30 / 750	496 / 1878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	6.25 / 1.90
FD-7HC	7 / 2.1	4.60 / 130.2	40 / 1133	42 / 1067	750 / 2839	2.1 / 1.9	3.0 - 5.5 / 0.9 - 1.7	7.25 / 2.20
FD-8HC	8 / 2.4	6.00 / 169.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	8.00 / 2.43

[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

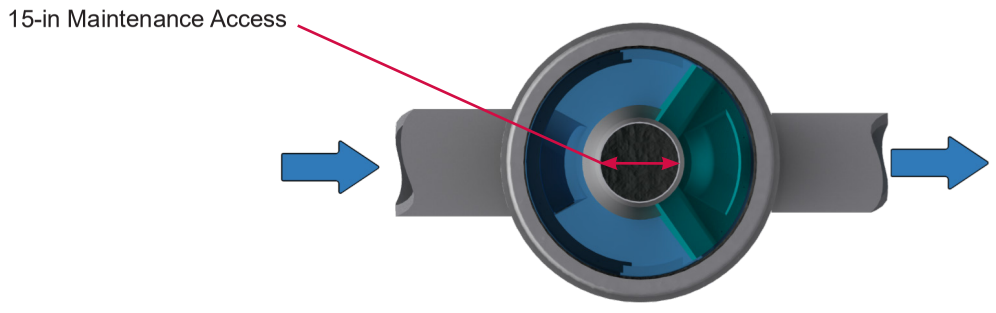


Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.
- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.

Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).

Maintenance at a Glance

Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	

First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): **FD-3HC** **FD-4** **FD-4HC** **FD-5HC** **FD-6** **FD-6HC** **FD-7HC** **FD-8HC**

INLET (CIRCLE ALL THAT APPLY): **GRATED INLET (CATCH BASIN)** **INLET PIPE (FLOW THROUGH)**

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

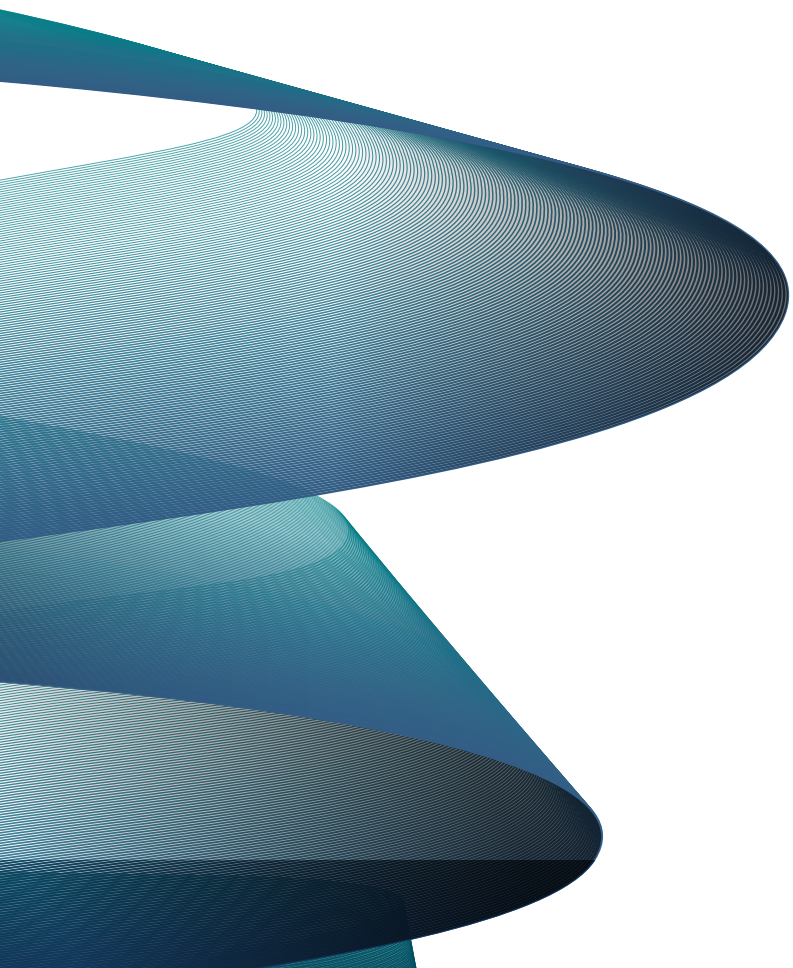
First Defense® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Notes

Hydro International®



Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

www.hydro-int.com

Turning Water Around...®

FDHC_O+M_H_1703

StormTech®

MC-3500 & MC-4500 Design Manual

StormTech® Chamber Systems for Stormwater Management

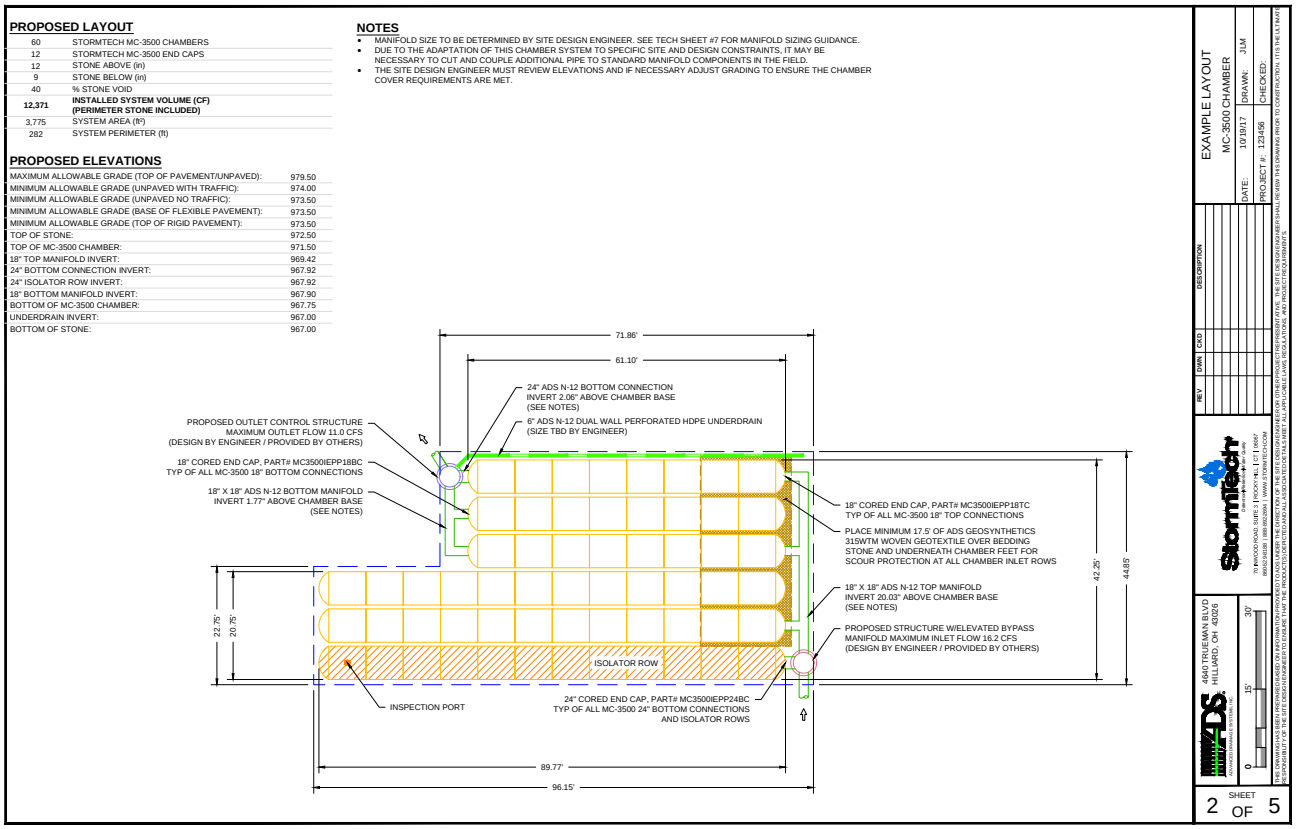
THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™

ADS®

Table of Contents

*For SC-310, SC-740 & DC-780 designs, please refer to the SC-310/SC-740/DC-780 Design Manual.

StormTech Engineering Services assists design professionals in specifying StormTech stormwater systems. This assistance includes the layout of chambers to meet the engineer's volume requirements and the connections to and from the chambers. They can also assist converting and cost engineering projects currently specified with ponds, pipe, concrete vaults and other manufactured stormwater detention/retention products. Please note that it is the responsibility of the site design engineer to ensure that the chamber bed layout meets all design requirements and is in compliance with applicable laws and regulations governing a project.



This manual is exclusively intended to assist engineers in the design of subsurface stormwater systems using StormTech chambers.

StormTech MC-3500 Chamber

MC-3500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for commercial and municipal applications.

StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	90” (2286 mm) x 77” (1956 mm) x 45” (1143 mm)
Chamber Storage	109.9 ft³ (3.11 m³)
Min. Installed Storage*	178.9 ft³ (5.06 m³)
Weight	134 lbs (60.8 kg)

*This assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-3500 End Cap (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	26.5” (673 mm) x 71” (1803 mm) x 45.1” (1145 mm)
Chamber Storage	14.9 ft³ (0.42 m³)
Min. Installed Storage*	46.0 ft³ (1.30 m³)
Weight	49 lbs (22.2 kg)

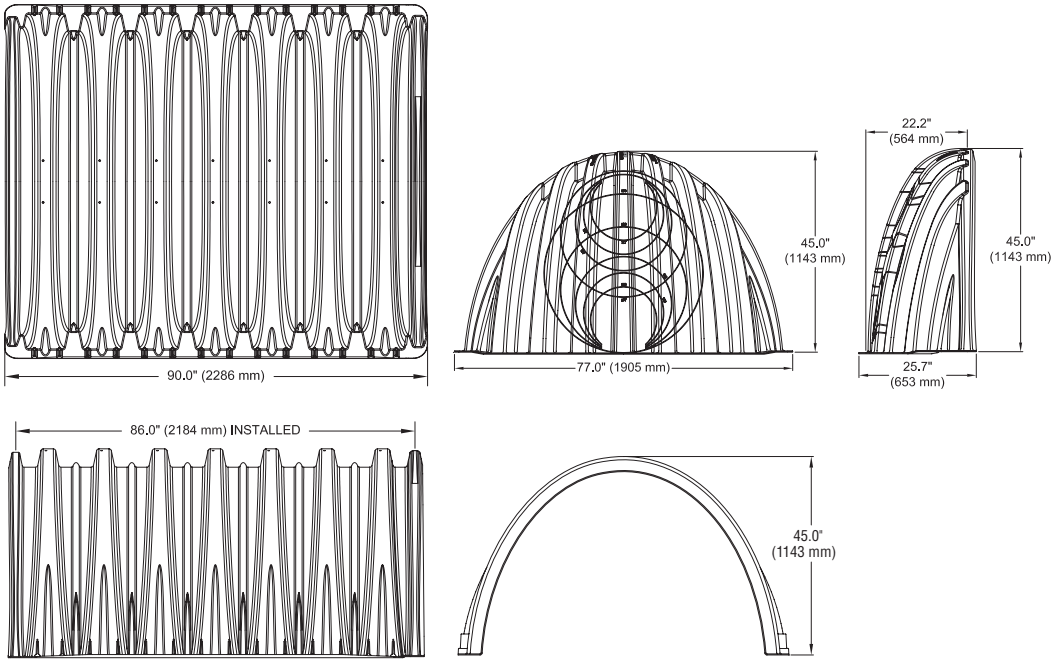
*This assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below, 6” (150 mm) of stone perimeter, 9” (230 mm) between chambers/end caps and 40% stone porosity.

Shipping

15 chambers/pallet

16 end caps/pallet

7 pallets/truck



StormTech MC-3500 Chamber

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	178.9 (5.06)	184.0 (5.21)	189.2 (5.36)	194.3 (5.5)
MC-3500 End Cap	14.9 (0.42)	46.0 (1.33)	47.7 (1.35)	49.4 (1.40)	51.1 (1.45)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (150 mm) stone perimeter.

Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500	9.1 (6.4)	9.7 (6.9)	10.4 (7.3)	11.1 (7.8)
End Cap	4.1 (2.9)	4.3 (3.0)	4.5 (3.2)	4.7 (3.3)
METRIC kg (m³)	230 mm	300 mm	375 mm	450 mm
MC-3500	8220 (4.9)	8831 (5.3)	9443 (5.6)	10054 (6.0)
End Cap	3699 (2.2)	3900(2.3)	4100 (2.5)	4301 (2.6)

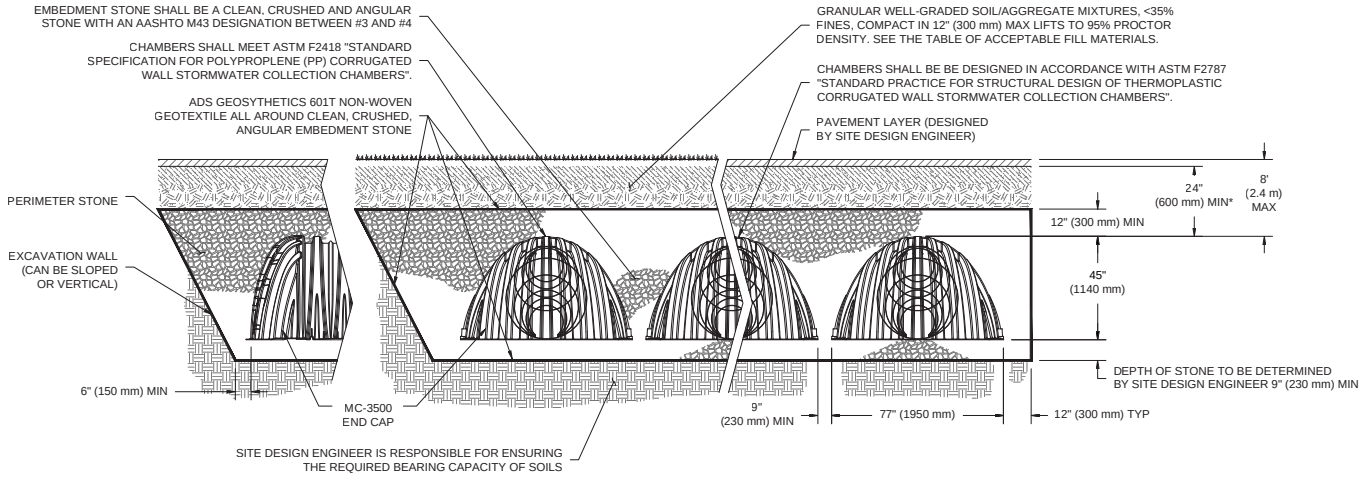
NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 6" (150 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
MC-3500	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)	13.8 (10.5)
End Cap	4.1 (3.1)	4.2 (3.2)	4.4 (3.3)	4.5 (3.5)

NOTE: Assumes 9" (230 mm) separation between chamber rows and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

General Cross Section



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

StormTech MC-4500 Chamber

MC-4500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for commercial and municipal applications.

StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	52” (1321 mm) x 100” (2540 mm) x 60” (1524 mm)
Chamber Storage	106.5 ft³ (3.01 m³)
Min. Installed Storage*	162.6 ft³ (4.60 m³)
Weight	120 lbs (54.4 kg)

*This assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below chambers, 9” (230)mm between chambers/end caps and 40% stone porosity.

StormTech MC-3500 End Cap (not to scale)

Nominal Chamber Specifications

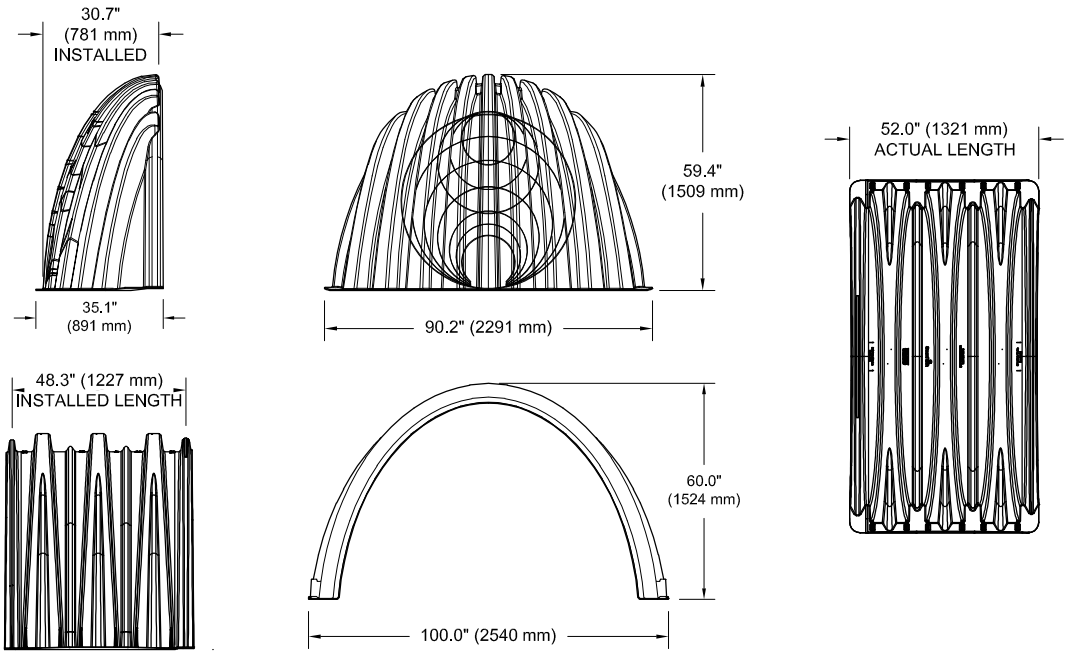
Size (L x W x H)	35.1” (891 mm) x 90.2” (2291 mm) x 59.4” (1509 mm)
Chamber Storage	35.7 ft³ (1.01 m³)
Min. Installed Storage*	108.7 ft³ (3.08 m³)
Weight	120 lbs (54.4 kg)

*This assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below, 6” (150 mm) of stone perimeter, 9” (230 mm) between chambers/end caps and 40% stone porosity.

Shipping

7 chambers/pallet

11 pallets/truck



StormTech MC-4500 Chamber

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-4500 Chamber	106.5 (3.02)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
MC-4500 End Cap	35.7 (1.01)	108.7 (3.08)	111.9 (3.17)	115.2 (3.26)	118.4 (3.35)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter.

Amount of Stone Per Chamber

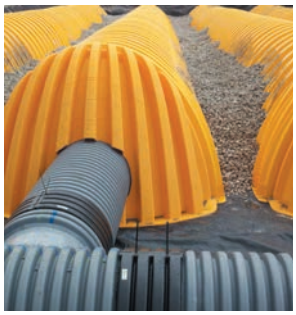
ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-4500	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.6 (6.8)	10.0 (7.1)	10.4 (7.4)	10.9 (7.7)
METRIC kg (m³)	230 mm	300 mm	375 mm	450 mm
MC-4500	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8691 (5.2)	9075 (5.4)	9460 (5.6)	9845 (5.9)

NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 12" (300 mm) of perimeter stone in front of end caps.

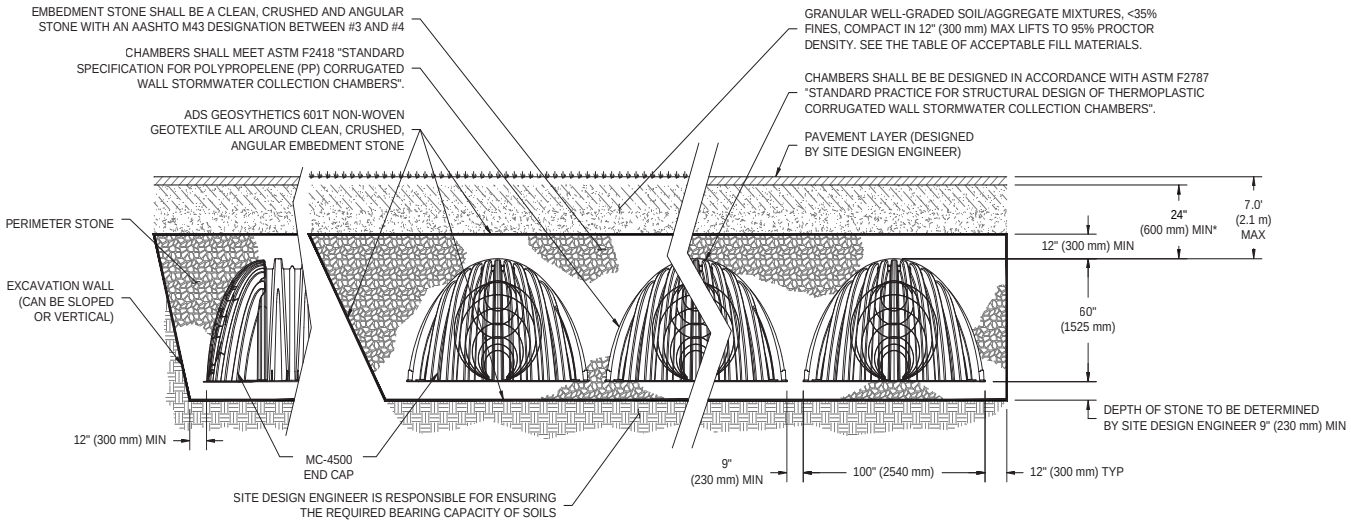
Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
MC-4500	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.3 (7.1)	9.6 (7.3)	9.9 (7.6)	10.2 (7.8)

NOTE: Assumes 9" (230 mm) separation between chamber rows, 12" (300 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.



General Cross Section



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Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

1.0 Product Information

1.1 PRODUCT DESIGN

StormTech's commitment to thorough product testing programs, materials evaluation and adherence to national standards has resulted in two more superior products. Like other StormTech chambers, the MC-3500 and MC-4500 are designed to meet the full scope of design requirements of the American Society of Testing Materials (ASTM) International specification F2787 "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" and produced to the requirements of the ASTM F 2418 "Standard Specification for Polypropylene (PP) Corrugated Stormwater Collection Chambers".

The StormTech MC-3500 and MC-4500 chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The ASTM F 2787 standard provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. of the AASHTO LRFD Bridge Design Specifications. ASTM F 2787 requires that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting ASTM F 2418. The three standards provide both the assurance of product quality and safe structural design.

The design of larger chambers in the same tradition of our other chambers required the collaboration of experts in soil-structure interaction, plastics and manufacturing. Years of extensive research, including laboratory testing and field verification, were required to produce chambers that are ready to meet both the rigors of installation and the longevity expected by engineers and owners.

This Design Manual provides the details and specifications necessary for consulting engineers to design stormwater management systems using the MC-3500 and MC-4500 chambers. It provides specifications for storage capacities, layout dimensions as well as requirements for design to ensure a long service life. The basic design concepts for foundation and backfill materials, subgrade bearing capacities and row spacing remain equally as pertinent for the MC-3500 and MC-4500 as the SC-740, SC-310 and DC-780 chamber systems. However, since many design values and dimensional requirements are different for these larger chambers than the SC-740, SC-310 and DC-780 chambers, design manuals and installation instructions are not interchangeable.

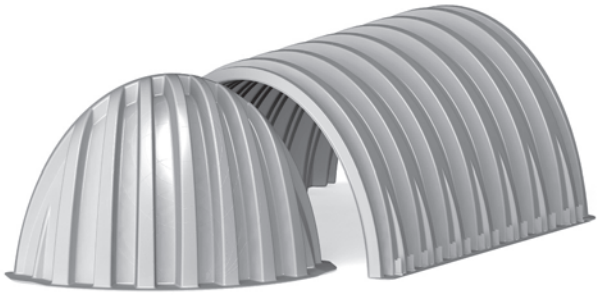
This manual includes only those details, dimensions, cover limits, etc for the MC-3500 and MC-4500 and is intended to be a stand-alone design guide for the MC-3500 and MC-4500 chambers. A Construction Guide specifically for these two chamber models has also been published.

1.2 TECHNICAL SUPPORT

The StormTech Technical Services Department is available to assist the engineer with the layout of MC-3500 and MC-4500 chamber systems and answer questions regarding all the StormTech chamber models. Call the Technical Services Department, email us at info@stormtech.com or contact your local StormTech representative.

1.3 MC-3500 AND MC-4500 CHAMBERS

All StormTech chambers are designed to the full scope of AASHTO requirements without repeating end walls or other structural reinforcing. StormTech's continuously curved, elliptical arch and the surrounding angular backfill are the key components of the structural system. With the addition of patent pending integral stiffening ribs **(Figure 5)**, the MC-3500 and MC-4500 are assured to provide a long, safe service life. Like other StormTech chambers, the MC-3500 and MC-4500 are produced from high quality, impact modified resins which are tested for short-term and long-term mechanical properties.



With all StormTech chambers, one chamber type is used for the start, middle and end of rows. Rows are formed by overlapping the upper joint corrugation of the next chamber over the lower joint corrugation of the previous chamber **(Figure 6)**.

1.4 CHAMBER JOINTS

All StormTech chambers are designed with an optimized joining system. The height and width of the end corrugations have been designed to provide the required structural safety factors while providing an unobstructed flow path down each row.

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. The corrugation valley immediately adjacent to the lower joint corrugation is marked “Overlap Here - Lower Joint.” The corrugation valley immediately adjacent to the upper joint corrugation is marked “Build This Direction - Upper Joint.”

Two people can safely and efficiently carry and place chambers without cumbersome connectors, special tools or heavy equipment. Each row of chambers must begin and end with a joint corrugation. Since joint corrugations are of a different size than the corrugations along the body of the chamber, chambers cannot be field cut and installed. Only whole MC-3500 and MC-4500 chambers can be used. For system layout assistance contact StormTech.

1.5 MC-3500 AND MC-4500 END CAPS

The MC-3500 and MC-4500 end caps are easy to install. These end caps are designed with a corrugation joint that fits over the top of either end of the chamber. The end cap joint is simply set over the top of either of the upper or lower chamber joint corrugations **(Figure 7)**.

The MC-3500 end cap has pipe cutting guides for 12”–24” (300 mm–600 mm) top inverts **(Figure 9)**.

The MC-4500 end cap has pipe cutting guides for 12”–42” (300 mm–1050 mm) bottom inverts and 12”–24” (300 mm–600 mm) top inverts **(Figure 8)**.

Standard and custom pre-cored end caps are available. Pre-cored end caps, 18” in diameter and larger include a welded crown plate.

FIGURE 5—Chamber and End Cap Components

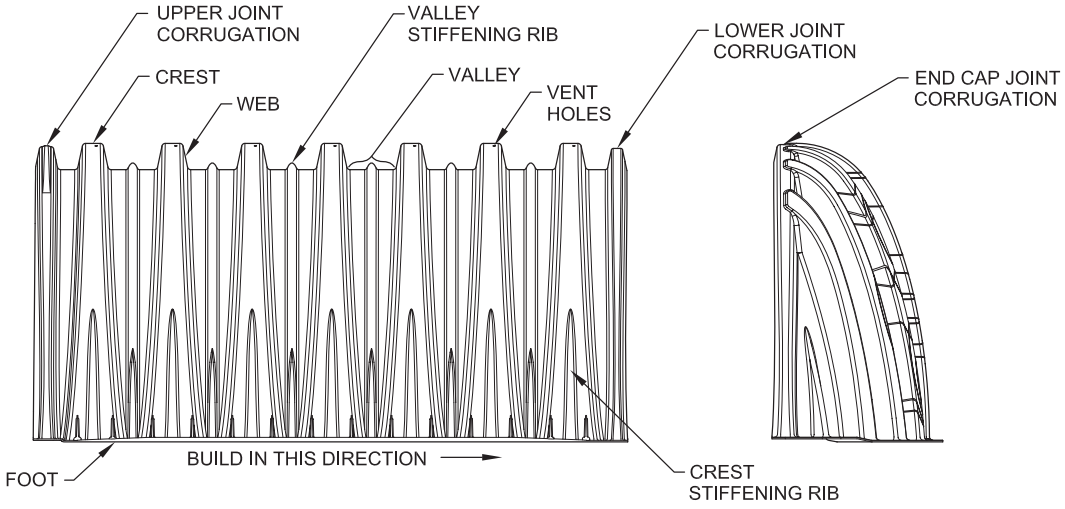


FIGURE 6—Chamber Joint Overlap

FIGURE 6—End Cap Joint Overlap

FIGURE 8—MC-4500 End Cap Inverts

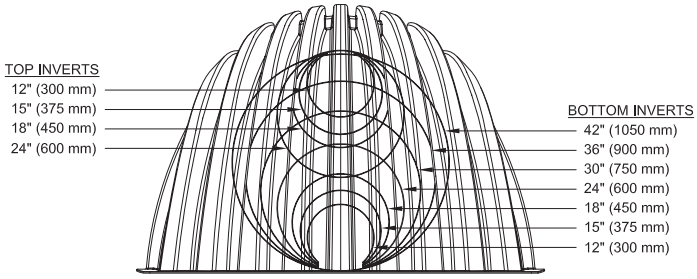
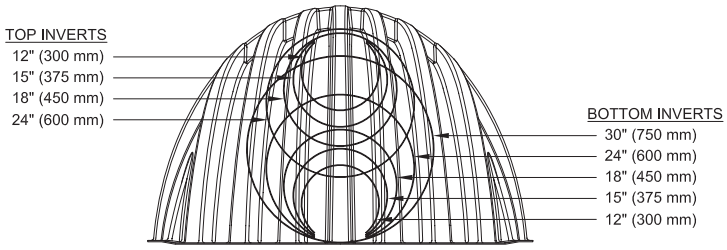


FIGURE 9—MC-4500 End Cap Inverts



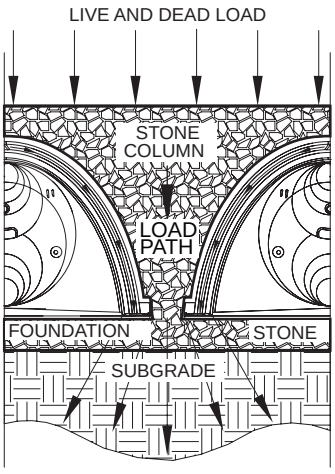
2.0 Foundations for Chambers

2.1 FOUNDATION REQUIREMENTS

StormTech chamber systems can be installed in various soil types. The subgrade bearing capacity and the cover height over the chambers determine the required depth of clean, crushed, angular foundation stone below the chambers. Foundation stone, also called bedding,

is the stone between the subgrade soils and the feet of the chamber. Flexible structures are designed to transfer a significant portion of both live and dead loads through the surrounding soils. Chamber systems accomplish this by creating load paths through the columns of embedment stone between and around the rows of chambers. This creates load concentrations at the base of the columns between the rows. The foundation stone spreads out the concentrated loads to distributed loads that can be supported by the subgrade soils.

Since increasing the cover height (top of chamber to finished grade) causes increasing soil load, a greater depth of foundation stone is necessary to distribute the load to the subgrade soils. **Table 1** and **2** specify the minimum required foundation depths for varying cover heights and allowable subgrade bearing capacities. These tables are based on StormTech service loads. The minimum required foundation depth is 9” (230 mm) for both chambers.



2.2 WEAKER SOILS

StormTech has not provided guidance for subgrade bearing capacities less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)]. These soils are often highly variable, may contain organic materials and could be more sensitive to moisture. A geotechnical engineer must be consulted if soils with bearing capacities less than 2000 psf (96 kPa) are present.

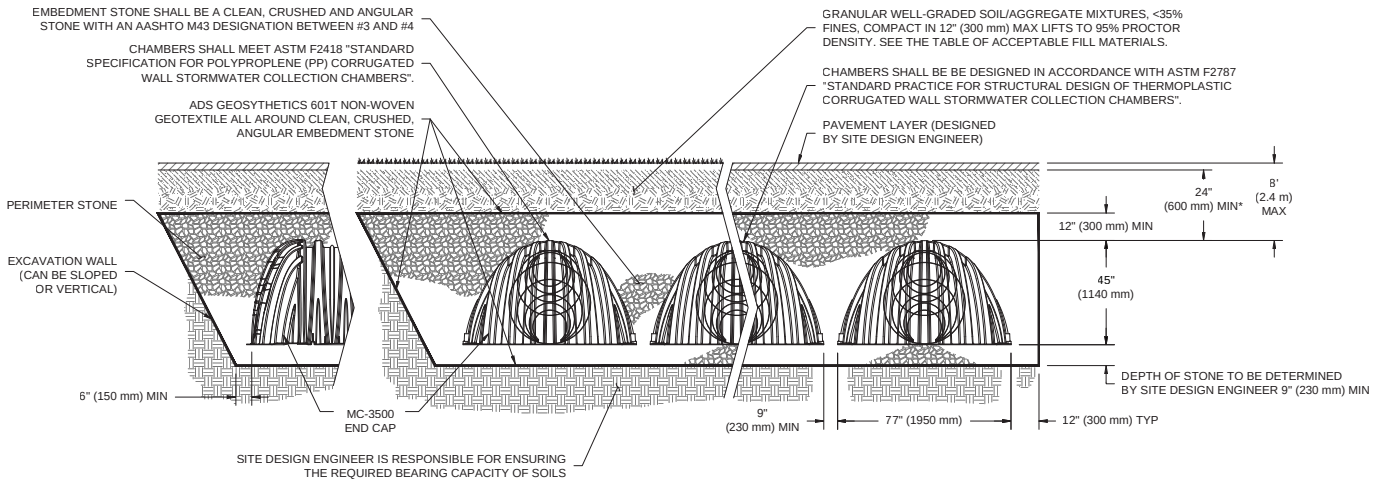
2.0 Foundations for Chambers

TABLE 1—MC-3500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 9” (230 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																							
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	24 (600)	24 (600)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	30 (750)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)
5.5 (1.68)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)
6.0 (1.83)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)
6.5 (1.98)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	30 (750)
7.0 (2.13)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	30 (750)	36 (900)
7.5 (2.30)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)
8.0 (2.44)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)	36 (900)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

FIGURE 10A—MC-3500 Structural Cross Section Detail (Not to Scale)



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

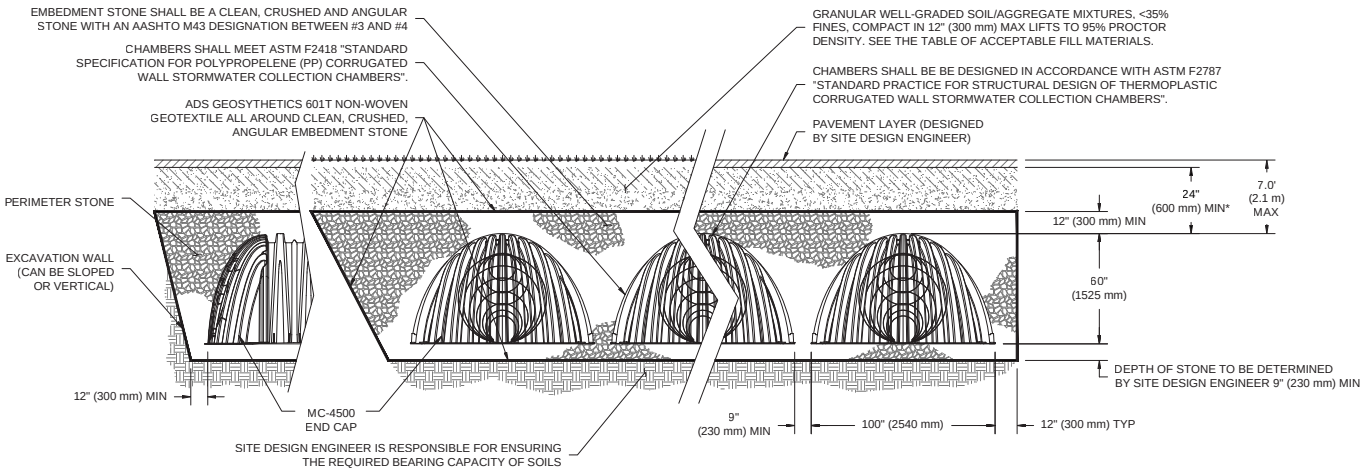
2.0 Foundations for Chambers

TABLE 2—MC-4500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 9” (230 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																								
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	18 (450)	18 (450)	24 (600)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	36 (900)
5.5 (1.68)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)
6.0 (1.83)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)	36 (900)
6.5 (1.98)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)	36 (900)	42 (1050)
7.0 (2.13)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	24 (600)	24 (600)	24 (600)	24 (600)	24 (600)	30 (750)	30 (750)	30 (750)	30 (750)	36 (900)	36 (900)	36 (900)	42 (1050)	42 (1050)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

FIGURE 10B—MC-4500 Structural Cross Section Detail (Not to Scale)



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

3.1 Foundation and Embedment Stone

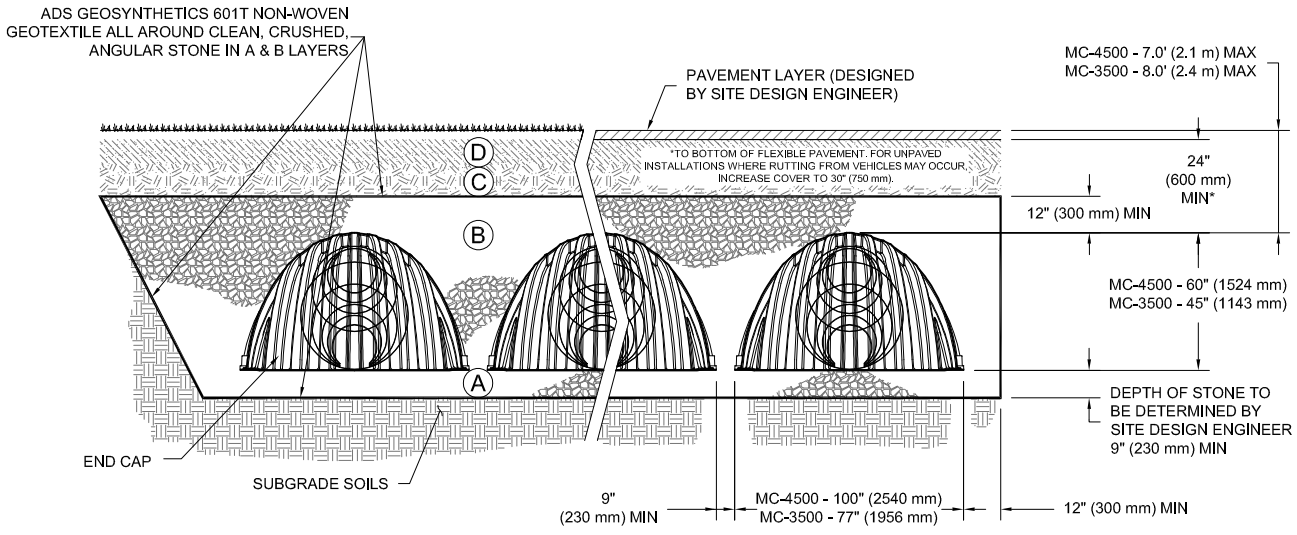
The stone surrounding the chambers consists of the foundation stone below the chambers and embedment stone surrounding the chambers. The foundation stone and embedment stone are important components of the structural system and also provide open void space for stormwater storage. **Table 3** provides the stone specifications that achieve both structural requirements and a porosity of 40% for stormwater storage. **Figure 11** specifies the extents of each backfill stone location.

TABLE 3—Acceptable Fill Materials

	MATERIAL LOCATION	DESCRIPTION	AASHTO DESIGNATION	COMPACTION/DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1,A-2-4,A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTOINS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDTIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL-GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FORM THE FOUDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2 3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.

FIGURE 11—Fill Material Locations



Once layer 'C' is placed, any soil/material can be placed in layer 'D' up to the finished grade. Most pavement subbase soils can be used to replace the materials of layer 'C' or 'D' at the design engineer's discretion.

3.0 Required Materials/Row Separation

3.2 FILL ABOVE CHAMBERS

Refer to **Table 3** and **Figure 11** for acceptable fill material above the clean, crushed, angular stone. StormTech requires a minimum of 24" (600 mm) from the top of the chamber to the bottom of flexible pavement. For non-paved installations where rutting from vehicles may occur StormTech requires a minimum of 30" (750 mm) from top of chamber to finished grade.

3.3 GEOTEXTILE SEPARATION

A non-woven geotextile meeting AASHTO M288 Class 2 separation requirements must be installed to completely envelope the system and prevent soil intrusion into the crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

3.4 PARALLEL ROW SEPARATION/ PERPENDICULAR BED SEPARATION

Parallel Row Separation

The minimum installed spacing between parallel rows after backfilling is 9" (230 mm) for the MC-3500 and MC-4500 chambers (measurement taken between the outside edges of the feet). Spacers may be used for layout convenience. Row spacing wider than the minimum spacing above may be specified.

Perpendicular Bed Separation

When beds are laid perpendicular to each other, a minimum installed spacing of 36" (900 mm) between beds is required.

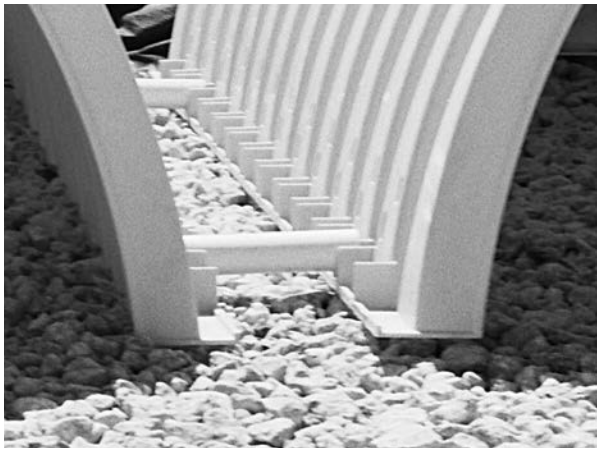
3.5 Special Structural Designs

StormTech engineers may provide special structural designs to enable deeper cover depths or increase the capacity to carry higher live loads. Special designs may utilize the additional strength that can be achieved by compaction of embedment stone or by increasing the spacing between rows.

Increasing the spacing between chamber rows may also facilitate the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where vertical restrictions on site prevent the use of a deeper foundation.

Contact ADS Engineering Services for more information on special structural designs.

System Cross Section



Minimum Row Spacing 9" (230 mm)

4.1 GENERAL

StormTech subsurface chamber systems offer the flexibility for a variety of inlet and outlet configurations. Contact the StormTech Technical Services Department or your local StormTech representative for assistance configuring inlet and outlet connections.

The open graded stone around and under the chambers provides a significant conveyance capacity ranging from approximately 0.8 cfs (23 l/s) to 13 cfs (368 l/s) per MC-3500 chamber and 0.54 cfs (15 l/s) to 8.5 cfs (240 l/s) for the MC-4500 chamber. The actual conveyance capacity is dependent upon stone size, depth of foundation stone and head of water. Although the high conveyance capacity of the open graded stone is an important component of the flow network, StormTech recommends that a system of inlet and outlet manifolds be designed to distribute and convey the peak flow through the chamber system.

It is the responsibility of the design engineer to provide the design flow rates and storage volumes for the stormwater system and to ensure that the final design meets all conveyance and storage requirements. However, StormTech will work with the design engineer to assist with manifold and chamber layouts that meet the design objectives.

4.2 THE ISOLATOR® ROW

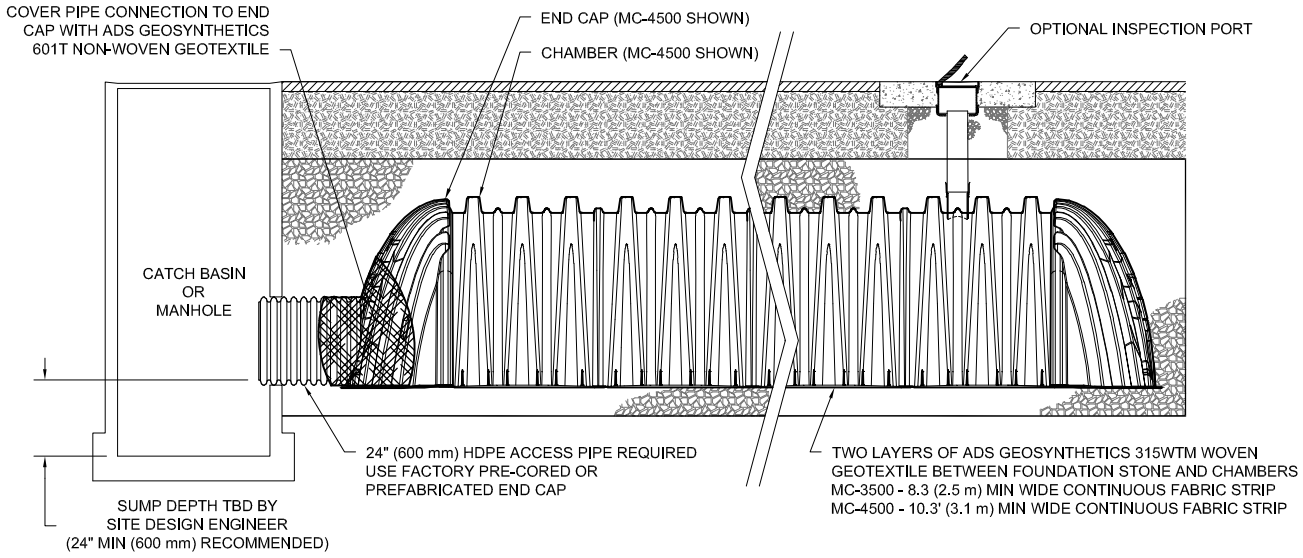
The Isolator Row is a patented system that inexpensively captures total suspended solids (TSS) and debris and provides easy access for inspection and maintenance. A double layer of woven geotextile between the bottom of the chambers and the foundation stone provides the filter media that satisfies most contaminant removal objectives. Each installed MC-3500 chamber and MC-3500 end cap provides 42.9 ft2 (4.0 m2) and 7.5 ft2 (0.7 m2) of bottom filter area respectively. Each installed MC-4500 chamber and MC-4500 end cap provides 30.1 ft^2 (2.80 m^2) and 12.8 ft^2 (1.19 m^2) of bottom filter area respectively.

The Isolator Row can be configured for maintenance objectives or, in some regulatory jurisdictions, for water quality objectives. For water quality applications, Isolator Rows can be sized based on water quality volume or flow rate.

All Isolator Rows require: 1) a manhole for maintenance access, 2) a means of diversion of flows to the Isolator Row and 3) a high flow bypass. Flow diversion can be accomplished by either a weir in the upstream access manhole or simply by feeding the Isolator Row at a lower elevation than the high flow bypass. Contact StormTech for assistance sizing Isolator Rows.

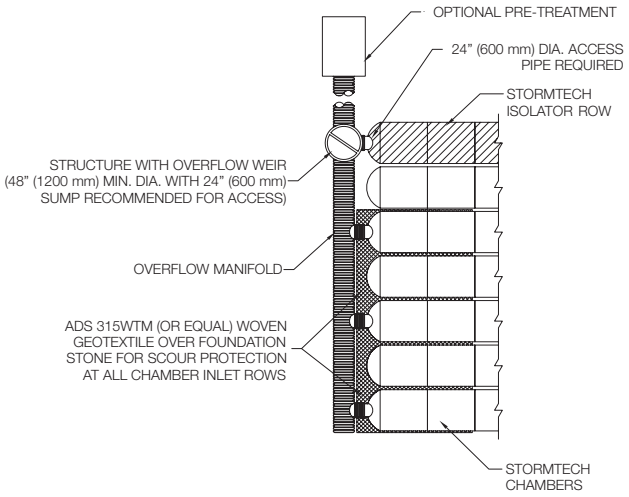
When additional stormwater treatment is required, StormTech systems can be configured using a treatment train approach where other stormwater BMPs are located in series.

FIGURE 12—StormTech Isolator Row Detail



4.0 Hydraulics

FIGURE 13—Typical Inlet Configuration With Isolator Row and Scour Protection



4.3 INLET MANIFOLDS

The primary function of the inlet manifold is to convey and distribute flows to a sufficient number of rows in the chamber bed such that there is ample conveyance capacity to pass the peak flows without creating an unacceptable backwater condition in upstream piping or scour the foundation stone under the chambers.

Manifolds are connected to the end caps either at the top or bottom of the end cap. Standard distances from the base of chamber to the invert of inlet and outlet manifolds connecting to StormTech end caps can be found in table 6. High inlet flow rates from either connection location produce a shear scour potential of the foundation stone. Inlet flows from top inlets also produce impingement scour potential. Scour potential is reduced when standing water is present over the foundation stone. However, for safe design across the wide range of applications, StormTech assumes minimal standing water at the time the design flow occurs.

To minimize scour potential, StormTech recommends the installation of woven scour protection fabric at each inlet row. This enables a protected transition zone from the concentrated flow coming out of the inlet pipe to a uniform flow across the entire width of the chamber for both top and bottom connections.

Allowable flow rates for design are dependent upon: the elevation of inlet pipe, foundation stone size and scour protection. With an appropriate scour protection geotextile installed from the end cap to at least 14.5 ft (4.42 m) in front of the inlet pipe for the MC-3500 and for the MC-4500, for both top and bottom feeds, the flow rates listed in **Table 4** can be used for all StormTech specified foundation stone gradations.

***See StormTech's Tech Sheet #7 for manifold sizing guidance.**

Table 4—Allowable Inlet Flows*

Inlet Pipe Diameter Inches (mm)	Allowable Maximum Flow Rate cfs (l/s)
12 (300)	2.48 (70)
15 (375)	3.5 (99)
18 (450)	5.5 (156)
24 (600)	8.5 (241) [MC-3500]
24 (600)	9.5 (269) [MC-4500]

*Assumes appropriate length of scour fabric per section 4.3

Table 5—Maximum Outlet Flow Rate Capacities From StormTech Oulet Manifolds

PIPE DIA.	FLOW (CFS)	FLOW (L/S)
6" (150 mm)	0.4	11.3
8" (200 mm)	0.7	19.8
10" (250 mm)	1.0	28.3
12" (300 mm)	2.0	56.6
15" (375 mm)	2.7	76.5
18" (450 mm)	4.0	113.3
24" (600 mm)	7.0	198.2
30" (750 mm)	11.0	311.5
36" (900 mm)	16.0	453.1
42" (1050 mm)	22.0	623.0
48" (1200 mm)	28.0	792.9

Table 6—Standard Distances From Base of Chamber to Invert of Inlet and Outlet Manifolds on StormTech End Caps

MC-3500 ENDCAPS			
	PIPE DIA.	INV. (IN)	INV. (MM)
TOP	6" (150 mm)	33.21	841
	8" (200 mm)	31.16	789
	10" (250 mm)	29.04	738
	12" (300 mm)	26.36	671
	15" (375 mm)	23.39	594
	18" (450 mm)	20.03	509
	24" (600 mm)	14.48	369
BOTTOM	12" (750 mm)	1.35	34
	15" (900 mm)	1.5	40
	18" (1050 mm)	1.77	46
	24" (1200 mm)	2.06	52

MC-4500 ENDCAPS			
	PIPE DIA.	INV. (IN)	INV. (MM)
	12" (300 mm)	35.69	907
	15" (375 mm)	32.72	831
	18" (450 mm)	29.36	746
	24" (600 mm)	23.05	585
BOTTOM	12" (750 mm)	1.55	34
	15" (900 mm)	1.7	43
	18" (1050 mm)	1.97	50
	24" (1200 mm)	2.26	57

4.4 OUTLET MANIFOLDS

The primary function of the outlet manifold is to convey peak flows from the chamber system to the outlet control structure. Outlet manifolds are often sized for attenuated flows. They may be smaller in diameter and have fewer row connections than inlet manifolds. In some applications however, the intent of the outlet piping is to convey an unattenuated bypass flow rate and manifolds may be sized similar to inlet manifolds.

Since chambers are generally flowing at or near full at the time of the peak outlet flow rate, scour is generally not governing and outlet manifold sizing is based on pipe flow equations. In most cases, StormTech recommends that outlet manifolds connect the same rows that are connected to an inlet manifold. This provides a continuous flow path through open conduits to pass the peak flow without dependence on passing peak flows through stone.

The primary function of the underdrains is to draw down water stored in the stone below the invert of the manifold. Underdrains are generally not sized for conveyance of the peak flow.

4.5 INSERTA TEE INLET CONNECTIONS

The maximum outlet flow rate capacities from StormTech outlet manifolds can be found in **Table 5.**

FIGURE 14—Typical Inlet, Outlet and Underdrain Configuration

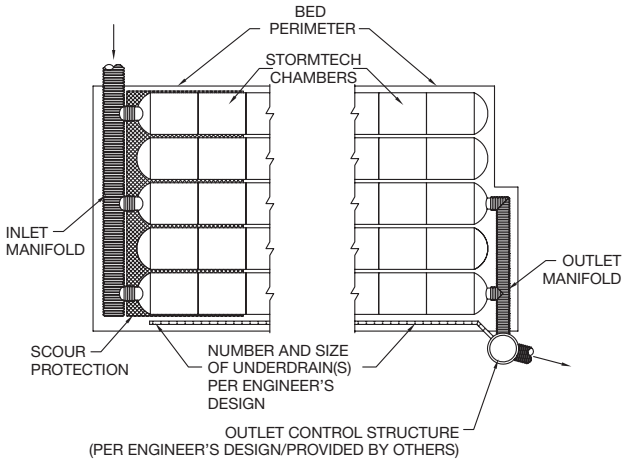
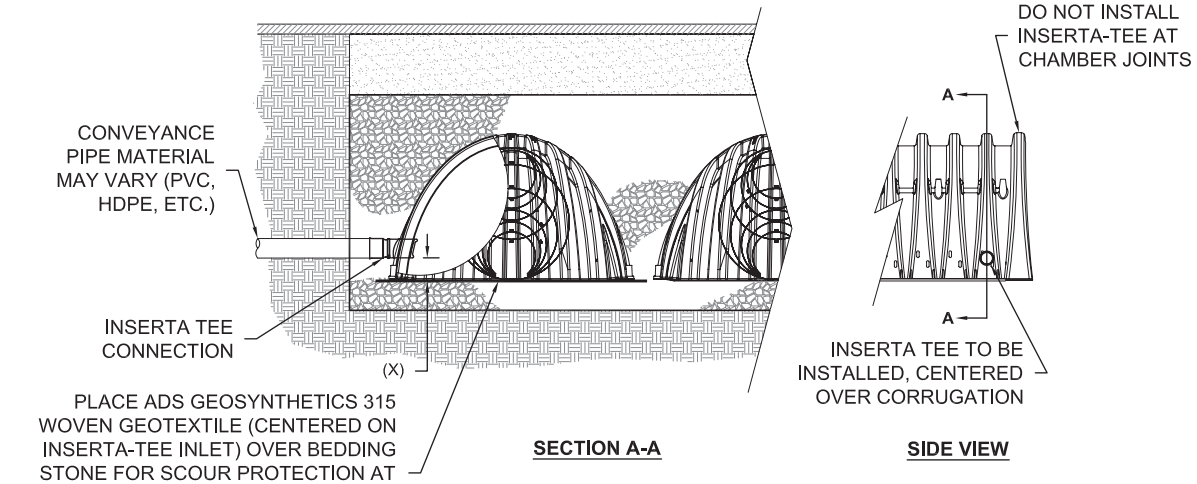


FIGURE 15—Inserta Tee Detail



CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
MC-3500	12" (250 mm)	6" (150 mm)
MC-4500	12" (250 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

5.0 Cumulative Storage Volumes

Tables 7 and **8** provide cumulative storage volumes for the MC-3500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 7 – MC-3500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above chambers, and 9" (230 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
66 (1676)	0.00	178.96 (5.068)
65 (1651)	0.00	177.25 (5.019)
64 (1626)	0.00	175.54 (4.971)
63 (1600)	Stone 0.00	173.83 (4.922)
62 (1575)	Cover 0.00	172.11 (4.874)
61 (1549)	0.00	170.40 (4.825)
60 (1524)	0.00	168.69 (4.777)
59 (1499)	0.00	166.98 (4.728)
58 (1473)	0.00	165.27 (4.680)
57 (1448)	0.00	163.55 (4.631)
56 (1422)	0.00	161.84 (4.583)
55 (1397)	0.00	160.13 (4.534)
54 (1372)	109.95 (3.113)	158.42 (4.486)
53 (1346)	109.89 (3.112)	156.67 (4.436)
52 (1321)	109.69 (3.106)	154.84 (4.385)
51 (1295)	109.40 (3.098)	152.95 (4.331)
50 (1270)	109.00 (3.086)	151.00 (4.276)
49 (1245)	108.31 (3.067)	148.88 (4.216)
48 (1219)	107.28 (3.038)	146.55 (4.150)
47 (1194)	106.03 (3.003)	144.09 (4.080)
46 (1168)	104.61 (2.962)	141.52 (4.007)
45 (1143)	103.04 (2.918)	138.86 (3.932)
44 (1118)	101.33 (2.869)	136.13 (3.855)
43 (1092)	99.50 (2.818)	133.32 (3.775)
42 (1067)	97.56 (2.763)	130.44 (3.694)
41 (1041)	95.52 (2.705)	127.51 (3.611)
40 (1016)	93.39 (2.644)	124.51 (3.526)
39 (991)	91.16 (2.581)	121.47 (3.440)
38 (965)	88.86 (2.516)	118.37 (3.352)
37 (948)	86.47 (2.449)	115.23 (3.263)
36 (914)	84.01 (2.379)	112.04 (3.173)
35 (889)	81.49 (2.307)	108.81 (3.081)
34 (864)	78.89 (2.234)	105.54 (2.989)
33 (838)	76.24 (2.159)	102.24 (2.895)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
32 (813)	73.52 (2.082)	98.90 (2.800)
31 (787)	70.75 (2.003)	95.52 (2.705)
30 (762)	67.92 (1.923)	92.12 (2.608)
29 (737)	65.05 (1.842)	88.68 (2.511)
28 (711)	62.12 (1.759)	85.21 (2.413)
27 (686)	59.15 (1.675)	81.72 (2.314)
26 (680)	56.14 (1.590)	78.20 (2.214)
25 (635)	53.09 (1.503)	74.65 (2.114)
24 (610)	49.99 (1.416)	71.09 (2.013)
23 (584)	46.86 (1.327)	67.50 (1.911)
22 (559)	43.70 (1.237)	63.88 (1.809)
21 (533)	40.50 (1.147)	60.25 (1.706)
20 (508)	37.27 (1.055)	56.60 (1.603)
19 (483)	34.01 (0.963)	52.93 (1.499)
18 (457)	30.72 (0.870)	49.25 (1.395)
17 (432)	27.40 (0.776)	45.54 (1.290)
16 (406)	24.05 (0.681)	41.83 (1.184)
15 (381)	20.69 (0.586)	38.09 (1.079)
14 (356)	17.29 (0.490)	34.34 (0.973)
13 (330)	13.88 (0.393)	30.58 (0.866)
12 (305)	10.44 (0.296)	26.81 (0.759)
11 (279)	6.98 (0.198)	23.02 (0.652)
10 (254)	3.51 (0.099)	19.22 (0.544)
9 (229)	0.00	15.41 (0.436)
8 (203)	0.00	13.70 (0.388)
7 (178)	0.00	11.98 (0.339)
6 (152)	Stone 0.00	10.27 (0.291)
5 (127)	Foundation 0.00	8.56 (0.242)
4 (102)	0.00	6.85 (0.194)
3 (76)	0.00	5.14 (0.145)
2 (51)	0.00	3.42 (0.097)
1 (25)	0.00	1.71 (0.048)

NOTE: Add 1.71 ft³ (0.030 m³) of storage for each additional inch (25 mm) of stone foundation.
Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volume

TABLE 8 – MC-3500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above end caps, and 9" (230 mm) of spacing between end caps and 6" (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
66 (1676)	0.00	46.96 (1.330)
65 (1651)	0.00	46.39 (1.314)
64 (1626)	0.00	45.82 (1.298)
63 (1600)	0.00	45.25 (1.281)
62 (1575)	0.00	44.68 (1.265)
61 (1549)	0.00	44.11 (1.249)
60 (1524)	0.00	43.54 (1.233)
59 (1499)	0.00	42.98 (1.217)
58 (1473)	0.00	42.41 (1.201)
57 (1448)	0.00	41.84 (1.185)
56 (1422)	0.00	41.27 (1.169)
55 (1397)	0.00	40.70 (1.152)
54 (1372)	15.64 (0.443)	40.13 (1.136)
53 (1346)	15.64 (0.443)	39.56 (1.120)
52 (1321)	15.63 (0.443)	38.99 (1.104)
51 (1295)	15.62 (0.442)	38.41 (1.088)
50 (1270)	15.60 (0.442)	37.83 (1.071)
49 (1245)	15.56 (0.441)	37.24 (1.054)
48 (1219)	15.51 (0.439)	36.64 (1.037)
47 (1194)	15.44 (0.437)	36.02 (1.020)
46 (1168)	15.35 (0.435)	35.40 (1.003)
45 (1143)	15.25 (0.432)	34.77 (0.985)
44 (1118)	15.13 (0.428)	34.13 (0.966)
43 (1092)	14.99 (0.424)	33.48 (0.948)
42 (1067)	14.83 (0.420)	32.81 (0.929)
41 (1041)	14.65 (0.415)	32.13 (0.910)
40 (1016)	14.45 (0.409)	31.45 (0.890)
39 (991)	14.24 (0.403)	30.75 (0.871)
38 (965)	14.00 (0.396)	30.03 (0.850)
37 (948)	13.74 (0.389)	29.31 (0.830)
36 (914)	13.47 (0.381)	28.58 (0.809)
35 (889)	13.18 (0.373)	27.84 (0.788)
34 (864)	12.86 (0.364)	27.08 (0.767)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
33 (838)	12.53 (0.355)	26.30 (0.745)
32 (813)	12.18 (0.345)	25.53 (0.723)
31 (787)	11.81 (0.335)	24.74 (0.701)
30 (762)	11.42 (0.323)	23.93 (0.678)
29 (737)	11.01 (0.312)	23.12 (0.655)
28 (711)	10.58 (0.300)	22.29 (0.631)
27 (686)	10.13 (0.287)	21.45 (0.607)
26 (680)	9.67 (0.274)	20.61 (0.583)
25 (635)	9.19 (0.260)	19.75 (0.559)
24 (610)	8.70 (0.246)	18.88 (0.559)
23 (584)	8.19 (0.232)	18.01 (0.510)
22 (559)	7.67 (0.217)	17.13 (0.485)
21 (533)	7.13 (0.202)	16.24 (0.460)
20 (508)	6.59 (0.187)	15.34 (0.434)
19 (483)	6.03 (0.171)	14.43 (0.409)
18 (457)	5.46 (0.155)	13.52 (0.383)
17 (432)	4.88 (0.138)	12.61 (0.357)
16 (406)	4.30 (0.122)	11.69 (0.331)
15 (381)	3.70 (0.105)	10.76 (0.305)
14 (356)	3.10 (0.088)	9.83 (0.278)
13 (330)	2.49 (0.071)	8.90 (0.252)
12 (305)	1.88 (0.053)	7.96 (0.225)
11 (279)	1.26 (0.036)	7.02 (0.199)
10 (254)	0.63 (0.018)	6.07 (0.172)
9 (229)	0.00	5.12 (0.145)
8 (203)	0.00	4.55 (0.129)
7 (178)	0.00	3.99 (0.113)
6 (152)	0.00	3.42 (0.097)
5 (127)	0.00	2.85 (0.081)
4 (102)	0.00	2.28 (0.064)
3 (76)	0.00	1.71 (0.048)
2 (51)	0.00	1.14 (0.032)
1 (25)	0.00	0.56 (0.016)

NOTE: Add 0.56 ft³ (0.016 m³) of storage for each additional inch (25 mm) of stone foundation.
Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

Tables 9 and **10** provide cumulative storage volumes for the MC-4500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 9 – MC-4500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above chambers, and 9" (230 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
81 (2057)	0.00	162.62 (4.065)
80 (2032)	0.00	161.40 (4.570)
79 (2007)	0.00	160.18 (4.536)
78 (1981)	0.00	158.98 (4.501)
77 (1956)	0.00	157.74 (4.467)
76 (1930)	0.00	156.62 (4.432)
75 (1905)	0.00	155.30 (4.398)
74 (1880)	0.00	154.09 (4.363)
73 (1854)	0.00	152.87 (4.329)
72 (1829)	0.00	151.65 (4.294)
71 (1803)	0.00	150.43 (4.294)
70 (1778)	0.00	149.21 (4.225)
69 (1753)	106.51 (3.016)	147.99 (4.191)
68 (1727)	106.47 (3.015)	146.75 (4.156)
67 (1702)	106.35 (3.012)	145.46 (4.119)
66 (1676)	106.18 (3.007)	144.14 (4.082)
65 (1651)	105.98 (3.001)	142.80 (4.044)
64 (1626)	105.71 (2.993)	141.42 (4.005)
63 (1600)	105.25 (2.981)	139.93 (3.962)
62 (1575)	104.59 (2.962)	138.31 (3.917)
61 (1549)	103.79 (2.939)	136.61 (3.869)
60 (1524)	102.88 (2.913)	134.85 (3.819)
59 (1499)	101.88 (2.885)	133.03 (3.767)
58 (1473)	100.79 (2.854)	131.16 (3.714)
57 (1448)	99.63 (2.821)	129.24 (3.660)
56 (1422)	98.39 (2.786)	127.28 (3.604)
55 (1397)	97.10 (2.749)	125.28 (3.548)
54 (1372)	95.73 (2.711)	123.25 (3.490)
53 (1346)	94.32 (2.671)	121.18 (3.490)
52 (1321)	92.84 (2.629)	119.08 (3.372)
51 (1295)	91.32 (2.586)	116.94 (3.311)
50 (1270)	89.74 (2.541)	114.78 (3.250)
49 (1245)	88.12 (2.495)	112.59 (3.188)
48 (1219)	86.45 (2.448)	110.37 (3.125)
47 (1194)	84.75 (2.400)	108.13 (3.062)
46 (1168)	83.00 (2.350)	105.86 (2.998)
45 (1143)	81.21 (2.300)	103.56 (2.933)
44 (1118)	79.38 (2.248)	101.25 (2.867)
43 (1092)	77.52 (2.195)	98.91 (2.801)

NOTE: Add 1.22 ft² (0.035 m²) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	75.62 (2.141)	96.55 (2.734)
41 (1041)	73.69 (2.087)	94.18 (2.667)
40 (1016)	71.72 (2.031)	91.78 (2.599)
39 (991)	69.73 (1.974)	89.36 (2.531)
38 (965)	67.70 (1.917)	86.93 (2.462)
37 (948)	65.65 (1.859)	84.48 (2.392)
36 (914)	63.57 (1.800)	82.01 (2.322)
35 (889)	61.46 (1.740)	79.53 (2.252)
34 (864)	59.32 (1.680)	77.03 (2.181)
33 (838)	57.17 (1.619)	74.52 (2.110)
32 (813)	54.98 (1.557)	71.99 (2.038)
31 (787)	52.78 (1.495)	69.45 (1.966)
30 (762)	50.55 (1.431)	66.89 (1.894)
29 (737)	48.30 (1.368)	64.32 (1.821)
28 (711)	46.03 (1.303)	61.74 (1.748)
27 (686)	43.74 (1.239)	59.19 (1.675)
26 (680)	41.43 (1.173)	56.55 (1.601)
25 (610)	39.11 (1.107)	53.93 (1.527)
24 (609)	36.77 (1.041)	51.31 (1.453)
23 (584)	34.41 (0.974)	48.67 (1.378)
22 (559)	32.03 (0.907)	46.03 (1.303)
21 (533)	29.64 (0.839)	43.38 (1.228)
20 (508)	27.23 (0.771)	40.71 (1.153)
19 (483)	24.81 (0.703)	38.04 (1.077)
18 (457)	22.38 (0.634)	35.37 (1.001)
17 (432)	19.94 (0.565)	32.68 (0.925)
16 (406)	17.48 (0.495)	29.99 (0.849)
15 (381)	15.01 (0.425)	27.29 (0.773)
14 (356)	12.53 (0.355)	24.58 (0.696)
13 (330)	10.05 (0.284)	21.87 (0.619)
12 (305)	7.55 (0.214)	19.15 (0.542)
11 (279)	5.04 (0.143)	16.43 (0.465)
10 (254)	2.53 (0.072)	13.70 (0.388)
9 (229)	0.00	10.97 (0.311)
8 (203)	0.00	9.75 (0.276)
7 (178)	0.00	8.53 (0.242)
6 (152)	Stone 0.00	7.31 (0.207)
5 (127)	Foundation 0.00	6.09 (0.173)
4 (102)	0.00	4.87 (0.138)
3 (76)	0.00	3.66 (0.104)
2 (51)	0.00	2.44 (0.069)
1 (25)	0.00	1.22 (0.035)

TABLE 10 – MC-4500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above end caps, and 9" (230 mm) of spacing between end caps and 6" (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
81 (2057)	0.00	108.69 (3.078)
80 (2032)	0.00	107.62 (3.047)
79 (2007)	0.00	106.54 (3.017)
78 (1981)	0.00	105.46 (2.986)
77 (1956)	0.00	104.38 (2.956)
76 (1930)	0.00	103.31 (2.925)
75 (1905)	0.00	102.23 (2.895)
74 (1880)	0.00	101.15 (2.864)
73 (1854)	0.00	100.07 (2.834)
72 (1829)	0.00	99.00 (2.803)
71 (1803)	0.00	97.92 (2.773)
70 (1778)	0.00	96.84 (2.742)
69 (1753)	35.71 (1.011)	95.76 (2.712)
68 (1727)	35.71 (1.011)	94.69 (2.681)
67 (1702)	35.70 (1.011)	93.60 (2.651)
66 (1676)	35.67 (1.010)	92.51 (2.620)
65 (1651)	35.62 (1.009)	91.40 (2.588)
64 (1626)	35.56 (1.007)	90.29 (2.557)
63 (1600)	35.47 (1.004)	89.16 (2.525)
62 (1575)	35.36 (1.001)	88.01 (2.492)
61 (1549)	35.21 (0.997)	86.85 (2.459)
60 (1524)	35.05 (0.992)	85.67 (2.426)
59 (1499)	34.86 (0.987)	84.48 (2.392)
58 (1473)	34.64 (0.981)	83.27 (2.358)
57 (1448)	34.40 (0.974)	82.05 (2.323)
56 (1422)	34.13 (0.966)	80.81 (2.288)
55 (1397)	33.83 (0.958)	79.55 (2.253)
54 (1372)	33.51 (0.949)	78.28 (2.217)
53 (1346)	33.16 (0.939)	77.00 (2.180)
52 (1321)	32.79 (0.928)	75.70 (2.144)
51 (1295)	32.39 (0.917)	74.38 (2.106)
50 (1270)	31.98 (0.906)	73.06 (2.069)
49 (1245)	31.54 (0.893)	71.71 (2.031)
48 (1219)	31.07 (0.880)	70.36 (1.992)
47 (1194)	30.59 (0.866)	68.99 (1.954)
46 (1168)	30.09 (0.852)	67.61 (1.915)
45 (1143)	29.56 (0.837)	66.22 (1.875)
44 (1118)	29.02 (0.822)	64.81 (1.835)
43 (1092)	28.45 (0.806)	63.40 (1.795)

NOTE: Add 1.08 ft³ (0.031 m³) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	27.87 (0.789)	61.97 (1.755)
41 (1041)	27.27 (0.772)	60.53 (1.714)
40 (1016)	26.65 (0.755)	59.08 (1.673)
39 (991)	26.01 (0.736)	57.62 (1.632)
38 (965)	25.35 (0.718)	56.15 (1.590)
37 (948)	24.68 (0.699)	54.67 (1.548)
36 (914)	23.99 (0.679)	53.18 (1.506)
35 (889)	23.28 (0.659)	51.68 (1.463)
34 (864)	22.56 (0.639)	50.17 (1.421)
33 (838)	21.82 (0.618)	48.64 (1.377)
32 (813)	21.06 (0.596)	47.11 (1.334)
31 (787)	20.29 (0.575)	45.57 (1.290)
30 (762)	19.50 (0.552)	44.02 (1.247)
29 (737)	18.70 (0.530)	42.46 (1.202)
28 (711)	17.88 (0.506)	40.89 (1.158)
27 (686)	17.04 (0.483)	39.31 (1.113)
26 (680)	16.19 (0.459)	37.73 (1.068)
25 (610)	15.33 (0.434)	36.14 (1.023)
24 (609)	14.46 (0.410)	34.53 (.0978)
23 (584)	13.58 (0.384)	32.93 (0.932)
22 (559)	12.68 (0.359)	31.31 (0.887)
21 (533)	11.77 (0.333)	29.69 (0.841)
20 (508)	10.85 (0.307)	26.06 (0.794)
19 (483)	9.91 (0.281)	26.42 (0.748)
18 (457)	8.97 (0.254)	24.77 (0.702)
17 (432)	8.01 (0.227)	23.12 (0.655)
16 (406)	7.04 (0.199)	21.46 (0.608)
15 (381)	6.07 (0.172)	19.80 (0.561)
14 (356)	5.08 (0.144)	18.13 (0.513)
13 (330)	4.08 (0.116)	16.45 (0.466)
12 (305)	3.07 (0.087)	14.77 (0.418)
11 (279)	2.06 (0.058)	13.09 (0.371)
10 (254)	1.03 (0.029)	11.39 (0.323)
9 (229)	0.00	9.70 (0.275)
8 (203)	0.00	8.62 (0.244)
7 (178)	0.00	7.54 (0.214)
6 (152)	Stone 0.00	6.46 (0.183)
5 (127)	Foundation 0.00	5.39 (0.153)
4 (102)	0.00	4.31 (0.122)
3 (76)	0.00	3.23 (0.092)
2 (51)	0.00	2.15 (0.061)
1 (25)	0.00	1.08 (0.031)

6.0 MC-3500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-3500 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 11—Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	178.9 (5.06)	184.0 (5.21)	189.2 (5.36)	194.3 (5.5)
MC-3500 End Cap	14.9 (0.42)	46.0 (1.30)	47.7 (1.35)	49.4 (1.40)	51.1 (1.45)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (150 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 11**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps. End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S). The size of the bed will depend on the number of chambers and end caps required:

MC-3500 area per chamber = 51.4 ft² (4.8 m²)
MC-3500 area per end cap = 13.5 ft² (1.3 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 12.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 12—Amount of Stone Per Chamber/End Cap

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500	9.1 (6.4)	9.7 (6.9)	10.4 (7.3)	11.1 (7.8)
End Cap	4.1 (2.9)	4.3 (3.1)	4.6 (3.2)	4.8 (3.4)
METRIC kg (m³)	230 mm	300 mm	375 mm	450 mm
MC-3500	8220 (4.9)	8831 (5.3)	9443 (5.6)	10054 (6.0)
End Cap	3699 (2.2)	3900 (2.3)	4100 (2.5)	4301 (2.6)

NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 6" (150 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.9 yd³ (1.5 m³) per MC-3500 chamber and 0.6 yd³ (0.5 m³) per MC-3500 end cap.

TABLE 13—Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
MC-3500	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)	13.8 (10.5)
End Cap	4.1 (3.1)	4.3 (3.3)	4.4 (3.4)	4.5 (3.5)

NOTE: Assumes 9" (230 mm) separation between chamber rows, 6" (150 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

6.0 MC-4500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-4500 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 14—Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-4500 Chamber	106.5 (3.01)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
MC-4500 End Cap	35.7 (1.01)	108.7 (3.08)	111.9 (3.17)	115.2 (3.26)	118.4 (3.35)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 14**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps. End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S). The size of the bed will depend on the number of chambers and end caps required:

MC-4500 area per chamber = 36.6 ft² (3.4 m²)
MC-4500 area per end cap = 23.2 ft² (2.2 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 15.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 15—Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-4500	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.6 (6.8)	10.0 (7.1)	10.4 (7.4)	10.9 (7.7)
METRIC kg (m³)	230 mm	300 mm	375 mm	450 mm
MC-4500	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8691 (5.2)	9075 (5.4)	9460 (5.6)	9845 (5.9)

NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 12" (300 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.4 yd³ (1.0 m³) per MC-4500 chamber and

TABLE 16—Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
MC-4500	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.3 (7.1)	9.6 (7.3)	9.9 (7.6)	10.2 (7.8)

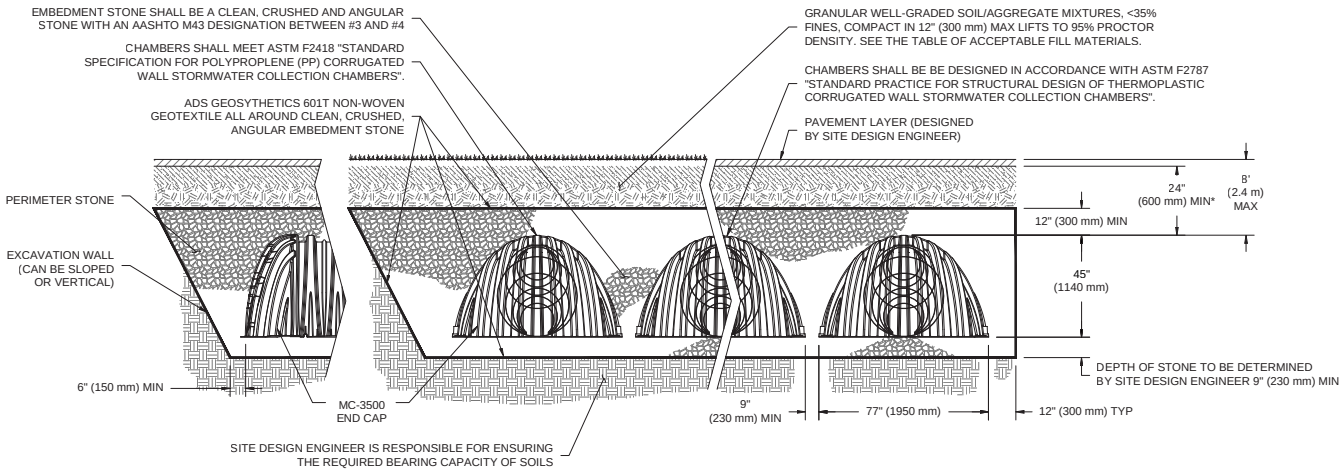
NOTE: Assumes 9" (230 mm) separation between chamber rows, 12" (300 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

1.4 yd³ (0.8 m³) per MC-4500 end cap.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

7.0 Structural Cross Sections and Specifications

FIGURE 16—MC-3500 Structural Cross Section Detail (Not to Scale)



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

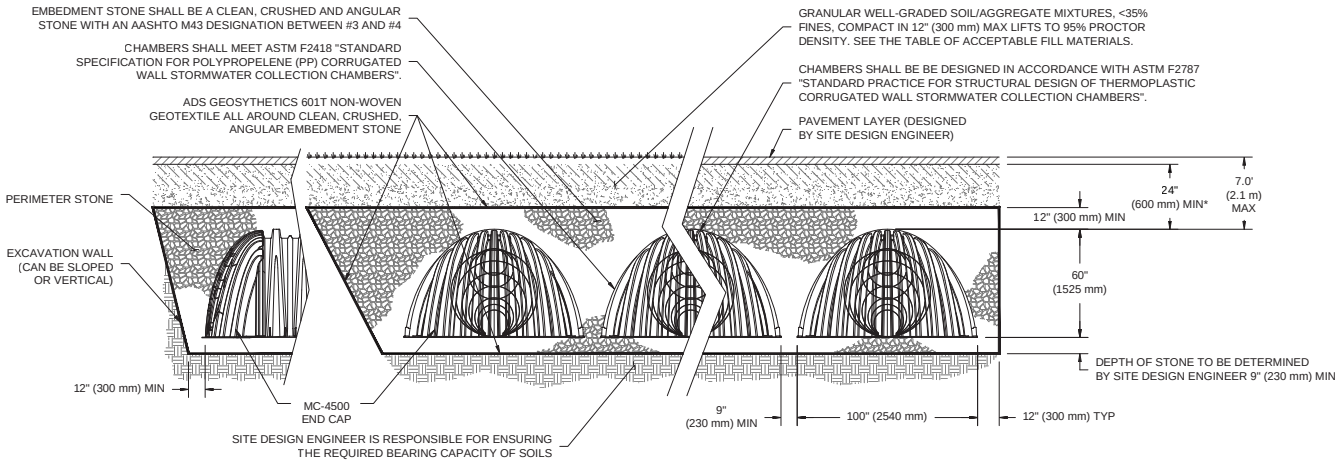
MC-3500 STORMWATER CHAMBER SPECIFICATIONS

1. Chambers shall be StormTech MC-3500 or approved equal.
2. Chambers shall be made from virgin, impact-modified polypropylene copolymers.
3. Chamber rows shall provide continuous, unobstructed internal space with no internal panels that would impede flow.
4. 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.
5. Chambers shall meet the requirements of ASTM F 2418, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers."
6. Chambers shall conform to the requirements of ASTM F 2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers."
7. 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 structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer's latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com

7.0 Structural Cross Sections and Specifications

FIGURE 16—MC-4500 Structural Cross Section Detail (Not to Scale)



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6. Chambers shall conform to the requirements of ASTM F 2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers."
7. 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 structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer's latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com

8.0 General Notes

1. StormTech ("StormTech") requires installing contractors to use and understand the latest **StormTech MC-3500 and MC-4500 Construction Guide** prior to beginning system installation.

2. StormTech offers installation consultations to installing contractors. Contact our Technical Service Department or local StormTech representative at least 30 days prior to system installation to arrange a pre-installation consultation. Our representatives can then answer questions or address comments on the StormTech chamber system and inform the installing contractor of the minimum installation requirements before beginning the system's construction. Call 860-529-8188 to speak to a Technical Service Representative or visit www.stormtech.com to receive a copy of our Construction Guide.

3. StormTech requirements for systems with pavement design (asphalt, concrete pavers, etc.): Minimum cover is 24" (600 mm) not including pavement; MC-3500 maximum cover is 8.0' (1.98 m) and MC-4500 maximum cover is 7.0' (2.43 m) both including pavement. For designs with cover depths deeper than these maximums, please contact Stormtech. For installations that do not include pavement, where rutting from vehicles may occur, minimum required cover is increased to 30" (762 mm).

4. The contractor must report any discrepancies with the bearing capacity of the subgrade materials to the design engineer.

5. AASHTO M288 Class 2 non-woven geotextile (ADS601 or equal) (filter fabric) must be used as indicated in the project plans.

6. Stone placement between chamber rows and around perimeter must follow instructions as indicated in the most current version of StormTech MC-3500 / MC-4500 Construction Guide.

7. Backfilling over the chambers must follow requirements as indicated in the most current version of StormTech MC-3500 / MC-4500 Construction Guide.

8. The contractor must refer to StormTech MC-3500 / MC-4500 Construction Guide for a Table of Acceptable Vehicle Loads at various depths of cover. This information is also available at the StormTech website: www.stormtech.com. The contractor is responsible for preventing vehicles that exceed StormTech requirements from traveling across or parking over the stormwater system. Temporary fencing, warning tape and appropriately located signs are commonly used to prevent unauthorized vehicles from entering sensitive construction areas.

9. The contractor must apply erosion and sediment control measures to protect the stormwater system during all phases of site construction per local codes and design engineer's specifications.

10. STORMTECH PRODUCT WARRANTY IS LIMITED. Contact StormTech for warranty information.

9.0 Inspection and Maintenance

9.1 ISOLATOR ROW INSPECTION

Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

Inspection ports can allow inspection to be accomplished completely from the surface without the need for a confined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection it is found that sediment has accumulated to an average depth exceeding 3" (76 mm), cleanout is required.

A StormTech Isolator Row should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater system. Inspection and maintenance, if necessary, should be performed prior to passing responsibility over to the site's owner. Once in normal service, a StormTech Isolator Row should be inspected bi-annually until an understanding of the sites characteristics is developed. The site's maintenance manager can then revise the inspection schedule based on experience or local requirements.

9.2 ISOLATOR ROW MAINTENANCE

JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1143 mm) are best. The JetVac process shall only be performed on StormTech Rows that have AASHTO class 1 woven geotextile over their foundation stone (ADS 315WTM or equal).

Looking down the Isolator Row

A typical JetVac truck (This is not a StormTech product.)

Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products).

A Family of Products and Services for the Stormwater Industry:

- MC-3500 and MC-4500 Chambers and End Caps
- SC-310 and SC-740 Chambers and End Caps
- DC-780 Chambers and End Caps
- Fabricated End Caps
- Fabricated Manifold Fittings
- Patented Isolator Row for Maintenance and Water Quality
- Chamber Separation Spacers
- In-House System Layout Assistance
- On-Site Educational Seminars
- Worldwide Technical Sales Group
- Centralized Product Applications Department
- Research and Development Team
- Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our Website

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