## MINIMUM STANDARD 3.10E

# PLASTIC CHAMBER SYSTEMS

### Definition

Plastic chambers are arch-shaped, open bottom, high-density plastic structures of various sizes and related storage capacities.

### Purpose

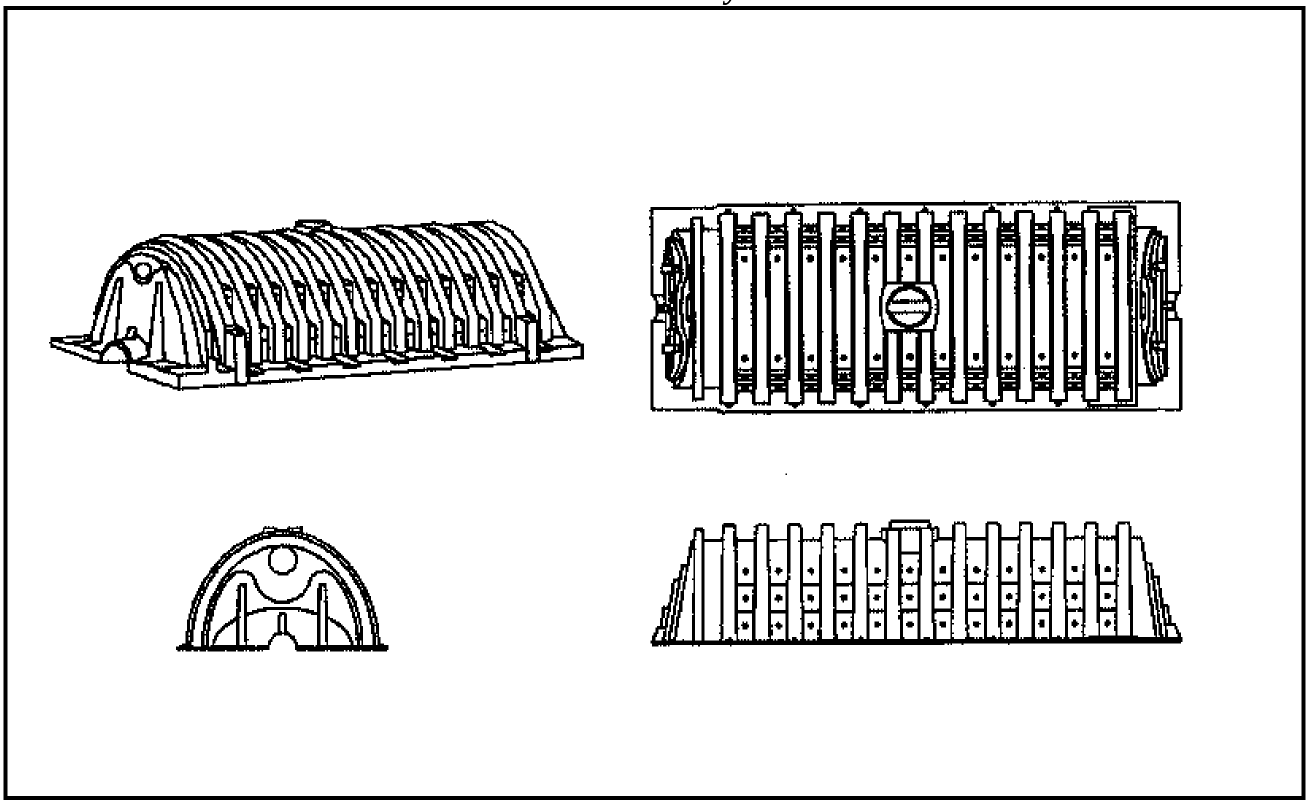
Plastic chambers are typically used as a component to a water quality BMP for providing increased subsurface storage volume for stormwater runoff. Infiltration trenches rely on the void ratio of the stone reservoir to hold the runoff while it slowly infiltrates into the subsoil. These chambers provide a large void capacity and can be used to increase the storage volume in order to store and therefore infiltrate a greater volume of runoff, or they can be used to decrease the required trench size and stone necessary to provide the equivalent required volume. The large open-bottom chamber design is also intended to provide increased water quality enhancement due to the relatively large area of bio-mat formation under the chambers, similar to the chambers' function when used for septic drain fields.

Plastic chamber systems can also be used to provide detention storage for purposes of stream channel erosion control, i.e. detention of runoff from the 1-year, 2-year, or even 10-year frequency storm.

It should be noted that these chambers can be used in a linear configuration, in place of conveyance pipe, from inlet structures to stormwater BMPs. Some of the larger chambers currently manufactured are capable of conveyance comparable to a 48 inch diameter pipe. An advantage of this alternative conveyance approach is to encourage infiltration in areas where it otherwise would not be provided.

**FIGURE 3.10E – 1**

***Plastic Chamber Systems***



*Note: Refer to manufacturer specification for dimensions. Several sizes and shapes are available.*

## Conditions Where Practice Applies

Plastic chamber systems are presented here as a component of infiltration practices. *Drainage Area* and *Development Condition* considerations and limitations associated with Infiltration Practices and Bioretention Basins will apply here, with the exception of allowing increased drainage area size as a function of the increased storage volume provided by utilizing the chambers. These chamber systems can be placed in the subsurface storage area of infiltration trenches, roof down spout systems, porous pavement, and bioretention basins and filters.

These chamber systems are most effective where the subsoil is sufficiently permeable to provide a reasonable infiltration rate and where the water table is low enough to prevent pollution of groundwater. However, where the subsoil is not sufficiently permeable to provide a reasonable infiltration rate, plastic chamber systems can be used as subsurface detention facilities for purposes of stream channel erosion or flood control. When these systems are used for detention purposes, the economics of placing detention underground, and therefore freeing up property which would otherwise be dedicated to a detention facility, must be weighed against the initial cost of the chamber system and the long term maintenance costs of the system. In general, a pretreatment design which prevents trash, debris, or excessive sediment from entering the chambers and potentially clogging the outlet device must be provided. Underground detention of stormwater raises concerns regarding maintenance. The structure will remain full of water for extended periods if debris clogs the outlet pipe. In some cases this may result in increased opportunities for infiltration. However, if the soils are not permeable, the structure will remain full and possibly cause the next storm to bypass or backup the system.

Plastic chambers are well suited for retrofit of existing stormwater systems to provide a water quality BMP and/or runoff quantity control benefits. This is particularly applicable in highly developed areas with storm sewer systems with little or no integrated water quality BMPs or water quantity controls. Relatively small plastic chamber systems can be “tucked” into available areas, can be used to replace existing stormwater conveyance pipe, or used in place of conveyance pipe for new construction.

Plastic chambers can also be used as an integral component of other infiltration facilities. When used in place of perforated pipe in an infiltration trench, the functional life of the infiltration trench can be extended due to the open bottom area of the chambers. When used within the base area of a bioretention facility, they increase the amount of water which can be filtered through the engineered soil media during storms which produce runoff in excess of the infiltration capacity of the underlying soils.

Infiltration facilities are not recommended for areas where Karst topography is present due to the possibility of causing subsurface collapse and solution channel formation.

Drainage Area

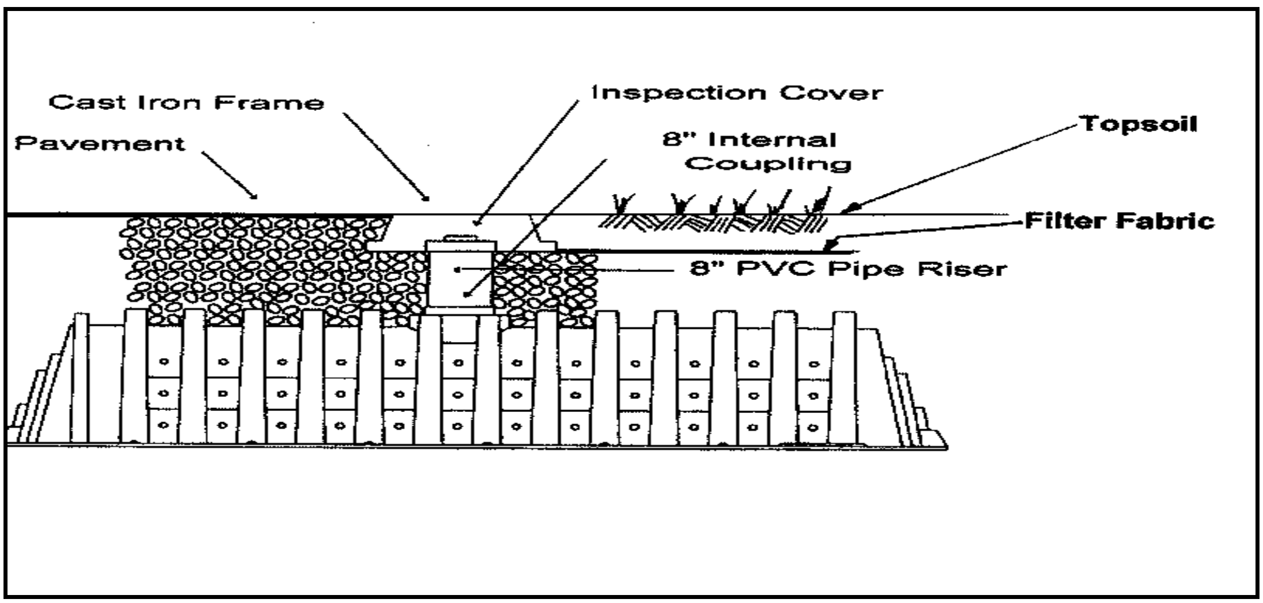
Plastic chamber systems are practical for small to medium sized drainage areas. Generally, plastic chamber systems can be used for drainage areas of up to 10 acres. For infiltration facilities which rely on the bottom surface area for infiltrating into the subsoil, the designer must check to verify that the facility will drain within the required time period. When the chambers are used under a Bioretention Filter (with an under drain system), the surface or planting area of the facility will determine the allowable drainage area.

Development Conditions

Because plastic chamber systems can be installed under trafficked or non-trafficked, open space or paved areas, they are equally well suited for low- to high- density residential, commercial, and industrial developments. They can be installed under roadways or within the roadway shoulder, or under parking lots, landscaped areas, tennis and basketball courts, play areas, or athletic fields. Smaller, multiple systems can be scattered throughout a site, under various types of land uses, each separate from the others with its own inlet structures. Due to their great flexibility in configuration and installation, plastic chamber systems can be configured in a single long line or in a rectangular or square "block" of numerous parallel rows of chambers. Other configurations are also possible by altering the number of chambers in different rows.

**FIGURE 3.10E – 2**

***Application of Plastic Chamber System Under Porous Pavement and Open Space***



## Planning Considerations

Planning considerations include site conditions: soil permeability, depth to seasonal high groundwater table and bedrock, topographic conditions; sediment (and debris) control: construction runoff and urban runoff; and maintenance. Site conditions must be reviewed to verify that the site does not overlay Karst topography. Soil permeability will determine whether the plastic chambers can be utilized as a water quality BMP to promote infiltration, or simply for temporary detention of stormwater. For further discussion, refer to the **Planning Considerations** previously discussed in **General Infiltration Practices, Minimum Standard 3.10**, and **Bioretention Basin Practices, Minimum Standard 3.10.**

## Design Criteria

The purpose of this section is to provide recommendations and minimum criteria for the design of plastic chamber systems. The designer must verify that the use of the selected product is in accordance with the manufacturers specifications.

Plastic stormwater chambers shall be designed to exceed the American Association of State Highway and Transportation Officials (AASHTO) recommended Load and Resistance Factor Design (LRFD) for earth loads and HS-20 live loads, with consideration for impact and multiple presences, when installed per the manufacturer's minimum requirements. It is the ultimate responsibility of the design engineer to seek verification from the plastic stormwater chamber's manufacturer that these structural requirements are met.

### General

Plastic chamber systems can be designed in many configurations to meet the specific limitations of the site and the main purpose for which they are being used, e.g. temporary storage of runoff as either detention or retention, for a water quality BMP, or for stormwater conveyance. This section shall focus on the use of plastic chamber systems for temporary storage of runoff and for a water quality BMP.

The reader should refer to **Minimum Standard 3.10B: Infiltration Trench** for soils investigation requirements, topographic conditions and limitations, design infiltration rate, and maximum storage time and trench depth. (Refer to manufacturers specifications for maximum depth and loading capacities of specific product models.)

The storage volume of a plastic chamber system is calculated by summing the void space provided by the chambers and that of the surrounding stone.

### Runoff Pretreatment

Preventative maintenance of subsurface storage systems, i.e. catch basins with sumps, silt diversion structures, siltation basins, etc. is in accordance with sound BMP practices. Additional chambers may be added to the system to compensate for potential loss of storage capacity. This has been achieved with some installations by replacing the inflow and/or outflow manifold pipes with chambers, and/or by using plastic chambers in place of conveyance pipe. Another approach includes segregating the first two or three chambers of each row from the rest of the plastic chamber system with high density plastic pipe connecting the upper holes in the end walls of the chambers. The first set of plastic chambers functions as a sediment trap. In this type of configuration, eight inch PVC risers can be placed on the first, and/or second chambers of the first two "up-flow" plastic chamber rows for observation and clean-out.

Backfill Material

Backfill material for plastic chamber systems should be clean 1½ to 2 inch hard granite-type stone aggregate up to at least the top of the chambers. Limestone aggregate should not be used in order to avoid the "pasting" of limestone fines that can deter infiltration. Additional aggregate of the same specifications can be added for the remaining fill to also function as the base for porous pavement (refer to **Minimum Standard 3.10D: Porous Pavement**), or to a height suitable for the addition of sufficient soil for grass and/or shrub placement.

A minimum of 6 inches of clean 1½ to 2 inch hard granite-type stone aggregate should also be placed as a base, underlying the plastic chamber system. A geotechnical investigation should be undertaken to determine if stabilization of the system base is needed.

Filter Fabric

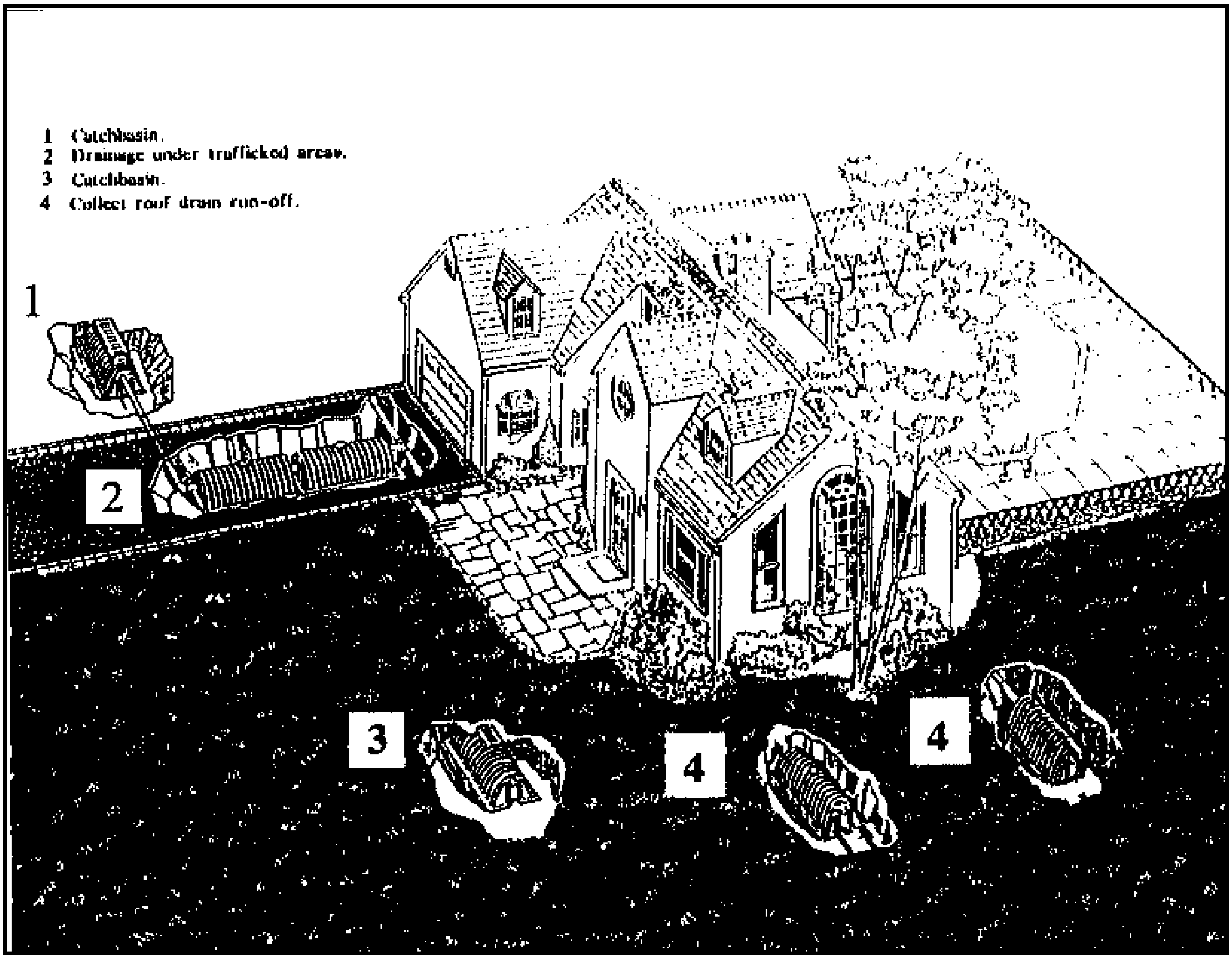
The top of the aggregate fill material should be covered with an engineering filter fabric. It is also recommended that an engineering filter fabric should be placed along the sides of the trench. Note, however, that filter fabric should **not** be placed on the trench bottom.

Overflow Channel

Because of the small drainage areas controlled by a plastic chamber system, an emergency spillway is not necessary. Due to their relatively higher void capacity, plastic chamber systems can hold relatively higher storage volumes. Plastic chamber systems, particularly with the larger chambers, are capable of retaining significant storm events without an overflow facility in many cases.

However, the overland flow path to be taken by the surface runoff, when the capacity of the plastic chamber system is exceeded, should always be evaluated. A nonerosive overflow channel leading to a stabilized watercourse should be provided, as necessary, to insure that uncontrolled, erosive, concentrated flow does not develop.

**FIGURE 3.10E – 3**
**Example Site Design Using Plastic Chamber Systems**




Observation Well

An observation well should be installed through the top of the first chambers of the first two rows receiving the runoff flow. The observation well will show how quickly the plastic chamber system drains following a storm, as well as providing a means of determining when maintenance is needed.

The observation wells should consist of perforated PVC pipe, 8 inches in diameter. They should be installed flush with the ground elevation of the plastic chamber system. The top of the well should be capped to discourage vandalism and tampering.

## Construction Specifications

Accepted construction standards and specifications should be followed where applicable. Specifications for the work should conform to the methods and procedures indicated for installing earthwork, concrete, reinforcing steel, pipe, water gates, metal work, woodwork and masonry, as they apply to the site and the purpose of the structure. The specification should also satisfy any requirements of the local government.

The use and installation of plastic chamber systems must be in conformance with all manufacturers specifications. Construction of a plastic chamber system should also be in conformance with the following:

Sequence of Construction

A plastic chamber system should not be constructed or placed into service until all of the contributing drainage area has been stabilized. Runoff from untreated, recently constructed areas within the drainage area may load the newly formed plastic chamber system and/or pretreatment facility with a large volume of fine sediment. Other devises, such as temporary inlet structure silt sacks, can be used until site stabilization is achieved.

The specifications for the construction of a plastic chamber system should state the following: 1) *the earliest point at which storm drainage may be directed to the plastic chamber system, and 2) the means by which this delay in use is to be accomplished*. Due to the wide variety of conditions encountered among development projects, each project should be evaluated separately to postpone the plastic chamber system use for as long as possible.

Trench Preparation

Trench excavation and preparation, stone placement, and filter fabric placement should conform to the Construction Specifications of **Infiltration Trenches: Minimum Standard 3.10B**.

The trench should be excavated with a backhoe or similar device that allows the equipment to stand away from the trench bottom. This bottom surface should be scarified with the excavator bucket teeth on the final pass to eliminate any smearing or shearing of the soil surface. Similarly, the stone aggregate base should be placed on the trench bottom so that it does not compact or smear the soil surface. Clean, washed, broken hard granite-type stone, 1½ to 2 inches, should be used instead of limestone. Limestone and its associated fines, with prolonged exposure to water, tends to leave a pasty residue which retards infiltration.

Large tree roots must be trimmed flush with the trench sides to prevent the fabric from puncturing or tearing during subsequent installation procedures. No void between the filter fabric and the excavation walls should be present. If boulders or similar obstacles are removed from the excavated walls, natural soils should be placed in these voids before the filter fabric in installed. The sidewalls of the trench should be roughened where sheared and sealed by heavy equipment.

Plastic Chamber System Placement

The first chamber of each row of the plastic chamber system is placed upon the stone aggregate base and the inlet manifold system installed. Sufficient additional stone aggregate is placed around the chambers and the inlet manifold system to hold the chambers in place so that the next chamber in each row can be installed. Additional stone aggregate is then placed on these chambers to hold them in place. The process progresses until all chambers are in place and the outlet manifold, if utilized, is installed. Extra care should be taken when placing stone at the end walls at the end of each chamber row. Place stone along the centerline of the top of the end chambers to spill over the ends. Placing a large amount of stone directly against the end walls could cause them to deform.

Inlet Manifold Installation

An inlet manifold is used to disperse the runoff into the rows of the plastic chamber system. Under normal conditions, laterals are used off of the header pipe into every other row. Where large flash flows are anticipated, laterals should be placed into every row of the plastic chamber system. A minimum diameter for the laterals is 4 inches; 12 inch laterals are recommended for sites where typical flow conditions are anticipated. Some of the larger plastic chambers can accommodate up to 24 inch laterals.

Outlet Manifold Installation

An outlet manifold can be used at the down-flow end of a plastic chamber system. Construction specifications are the same as for the inlet manifold. Alternatives to an outlet manifold include placing the plastic chamber system off-line or directing chamber flow from the inlet structure at a lower elevation than the excess flow.

Stone Aggregate Fill Placement

At a minimum, place enough additional fill of the 1½ to 2 inch washed stone aggregate to just cover the chambers. The top of this fill should be level.

Backfill

Plastic chamber systems are typically backfilled with soil. Additional 1½ to 2 inch washed stone aggregate can also be used up to the minimum depth needed for soil to support a vegetative cover or for placement of the base for porous pavement.

Surface Cover Placement
For areas proposed for open space, grass, ground cover or shrubs can be used. The use of trees is not recommended to avoid possible problems with roots extending into the chambers.

For areas proposed for porous pavement, sufficient depth should be left for placement of the pavement base and the overlying pavement.

Observation Wells
Observation wells should be provided as specified in the design criteria. The depth of the well at the time of installation should be clearly marked on the well cap.

The following maintenance and inspection guidelines are not intended to be all-inclusive. Specific facilities may require other measures not discussed here.

## Maintenance / Inspection Guidelines

Inspection Schedule

Same as for **Infiltration Trench, Minimum Standard 3.10B.**

Sediment Control

Sediment buildup within the pretreatment structure should be monitored on the same schedule as the observation well within the trench and chamber system.

## Manufacturer Contacts

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