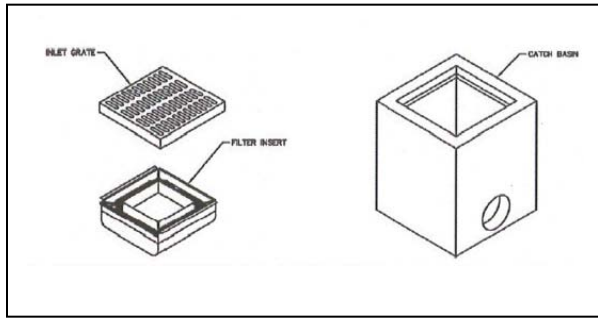


2K-4 Catch Basins with Sumps and Catch Basin Inserts



Schematic: Catch basin insert (PADEP)

Pollutant Removal			
	Low	Med	High
Suspended Solids			■
Nitrogen			
Phosphorous			
Metals			■
Bacteriological			
Hydrocarbons		■	

Description: A catch basin (also known as a storm drain inlet, curb inlet) is an inlet to the storm drain system that typically includes a grate or curb inlet where stormwater enters the catch basin. Catch basins may include a sump to capture sediment, debris, and associated pollutants. The performance of catch basins at removing sediment and other pollutants depends on the design of the catch basin (e.g., the size of the sump), and routine maintenance to retain the storage available in the sump to capture sediment. Catch basin inserts are filtration devices. The inserts allow stormwater to pass through filter media which are designed to reduce specific stormwater pollutants, primarily solids and oils. Pollutants are captured physically or through sorption onto the filter media. Filters may either be inserts that are retrofitted into existing catch basins or manholes, or stand alone units supplied by a manufacturer.

Typical Uses: Used in ultra high density and industrial, commercial sites for targeted removal of pollutants in stormwater runoff from small catchments (< 10 acres).

Advantages:

- Units are typically underground or within existing structures and do not consume much site space
- Filtration devices can be customized to reduce a specific pollutant of concern
- Can often be easily incorporated into fully developed sites
- Can be used for pre-treatment prior to infiltration practices
- Relevant for use on industrial sites because filters can remove pollutants such as metals and oils

Limitations:

- Efficiency has not been widely tested
- Each type of unit has specific design constraints and limitations for use
- Can be more costly than other treatment methods; high capital and operations and maintenance costs
- Treatment may be greatly reduced if frequent maintenance is not conducted
- Subject to freezing in cold climates

Maintenance Requirements:

- High degree of maintenance and weekly management required
- Service chemical feed equipment daily and/or weekly

A. Introduction

Filtration devices, depending on the design, can treat stormwater to reduce nutrients, sediment, floatables, metals, oil, and/or organic compounds. Different filtration media are used depending on the type of pollutant to be removed. Filter media may be a screen, fabric, activated carbon, perlite, zeolite, or another material. Often a combination of filter media can be used to target the specific pollutants of interest. Catch basin inserts represent a special type of filtration practice that can be used for treatment in small catchments for specific targeted pollutant removal.

B. Description

Catch basins, also known as storm drain inlets and curb inlets, are inlets to the storm drain system. They typically include a grate or curb inlet and could include a sump to capture sediment, debris, and pollutants. Catch basins may be used in combined sewer overflow (CSO) watersheds to capture floatables and settle some solids; they act as pretreatment for other treatment practices by capturing large sediments. The effectiveness of catch basins with sumps, their ability to remove sediments and other pollutants, depends on its design (e.g., the size of the sump) and on maintenance procedures to regularly remove accumulated sediments from its sump. Inserts designed to remove oil and grease, trash, debris, and sediment can improve the efficiency of catch basins. Some inserts are designed to drop directly into existing catch basins, while others may require retrofit construction.

These devices differ from structural stormwater filters in two aspects. First, these devices are proprietary and are designed to fit as an insert into the hydraulic infrastructure (e.g. catch basin). Second, the media material may have unique characteristics that are different from the soil/sand media recommended for general stormwater filtration. Filtration devices have been developed for use in locations such as underground chambers, catch basins, trench drains, and roof drains. The manufacturer specifications should indicate key design parameters such as size, allowable flow rate, allowable pollutant concentrations, and removal efficiency. A bypass should be part of the system to allow high flows to circumvent the filtration device. Performance data is often provided by the manufacturer. Users should review this information to ensure it was provided by an independent source.

C. Selection of catch basin insert filtration devices

When selecting or specifying a catch basin insert filtration device, designers should research the following:

1. What are the minimum or maximum drainage areas recommended for the device or method?
2. What flow rates or volumes can the device accommodate? Will accessory structures be necessary to divert high flow around the filtration device?
3. What are the characteristics of the pollutants in the water used for testing? What particle size distribution was tested? Research protocols used for testing.
4. Are pollutant removal tests verified by independent organizations such as the Technology Verification ETV program.
5. Does the device contain a by-pass for high flows? If so, what is the percentage of flow prior to by-pass.

6. What are the construction costs? Does the cost include all materials, installation, and delivery?
7. What are the maintenance requirements? What are the costs of the required maintenance? Is there a standard operation and maintenance plan? What is the typical life of the filtration unit?
8. Does the local regulatory authority approve the use of filtration devices?
9. Will the manufacturer provide design computations and CADD details?

D. Applicability

Though they are used in drainage systems throughout the United States, many catch basins are not ideally designed for sediment and pollutant capture. Catch basins with sumps are ideally used as pretreatment to another stormwater management practice. Retrofitting existing catch basins may substantially improve their performance. A simple retrofit option is to ensure that all catch basins have a hooded outlet to prevent floatable materials, such as trash and debris, from entering the storm drain system. Catch basin inserts for both new development and retrofits at existing sites may be preferred when available land is limited, as in urbanized areas.

E. Limitations

Catch basins have three major limitations:

- Even ideally designed catch basins cannot remove pollutants as well as structural stormwater management practices, such as wet ponds, sand filters, and stormwater wetlands.
- Unless frequently maintained, catch basins can become a source of pollutants through re-suspension.
- Catch basins cannot effectively remove soluble pollutants or fine particles.

F. Siting and design considerations

The performance of catch basins with sumps is related to the volume in the sump (i.e., the storage in the catch basin below the outlet). Lager et al. (1997) described an "optimal" catch basin sizing criterion, which relates all catch basin dimensions to the diameter of the outlet pipe (D):

- The diameter of the catch basin should be equal to 4D.
- The sump depth should be at least 4D. This depth should be increased if cleaning is infrequent or if the area draining to the catch basin has high sediment loads.
- The top of the outlet pipe should be 1.5 D from the bottom of the inlet to the catch basin.

Catch basins sumps should also be sized to accommodate the volume of sediment that enters the system. Pitt et al. (1997) proposed a sizing criterion based on the concentration of sediment in stormwater runoff. The catch basin is sized, with a factor of safety, to accommodate the annual sediment load in the catch basin sump. This method is preferable where high sediment loads are anticipated, and where the optimal design described above is suspected to provide little treatment.

The basic design should also incorporate a hooded outlet to prevent floatable materials and trash from entering the storm drain system. Adding a screen to the top of the catch basin would not likely improve the performance of catch basins for pollutant removal, but it would help capture trash entering the catch basin (Pitt et al., 1997).

Several varieties of catch basin inserts exist for filtering runoff. There are two basic catch basin insert varieties. One insert option consists of a series of trays, with the top tray serving as an initial sediment trap, and the underlying trays composed of media filters. Another option uses filter fabric to remove pollutants from stormwater runoff. Yet another option is a plastic box that fits directly into the catch basin. The box construction is the filtering medium. Hydrocarbons are removed as the stormwater passes through the box while trash, rubbish, and sediment remain in the box as stormwater exits. These devices have a very small volume, compared to the volume of the catch basin sump, and would typically require very frequent sediment removal. Bench test studies found that a variety of options showed little removal of total suspended solids, partially due to scouring from relatively small (6 month) storm events (ICBIC, 1995).

One design adaptation of the standard catch basin is to incorporate infiltration through the catch basin bottom. Two challenges are associated with this design. The first is potential ground water impacts, and the second is potential clogging, preventing infiltration. Infiltrating catch basins should not be used in commercial or industrial areas, because of possible ground water contamination. While it is difficult to prevent clogging at the bottom of the catch basin, it might be possible to incorporate some pretreatment into the design.

G. Maintenance considerations

Typical maintenance of catch basins includes trash removal if a screen or other debris capturing device is used, and removal of sediment using a vactor truck. Operators need to be properly trained in catch basin maintenance. Maintenance should include keeping a log of the amount of sediment collected and the date of removal. Some cities have incorporated the use of GIS systems to track sediment collection and to optimize future catch basin cleaning efforts.

One study (Pitt, 1985) concluded that catch basins can capture sediments up to approximately 60 percent of the sump volume. When sediment fills greater than 60% of their volume, catch basins reach steady state. Storm flows can then re-suspend sediments trapped in the catch basin, and will bypass treatment. Frequent cleaning can retain the volume in the catch basin sump available for treatment of stormwater flows.

At a minimum, catch basins should be cleaned once or twice per year (Aronson et al., 1993). Two studies suggest that increasing the frequency of maintenance can improve the performance of catch basins, particularly in industrial or commercial areas. One study of 60 catch basins in Alameda County, California, found that increasing the maintenance frequency from once per year to twice per year could increase the total sediment removed by catch basins on an annual basis (Mineart and Singh, 1994). Annual sediment removed per inlet was 54 pounds for annual cleaning, 70 pounds for semi-annual and quarterly cleaning, and 160 pounds for monthly cleaning. For catch basins draining industrial uses, monthly cleaning increased total annual sediment collected to six times the amount collected by annual cleaning (180 pounds versus 30 pounds). These results suggest that, at least for industrial uses, more frequent cleaning of catch basins may improve efficiency. However, the cost of increased operation and maintenance costs needs to be weighed against the improved pollutant removal.

In some regions, it may be difficult to find environmentally acceptable disposal methods for collected sediments. The sediments may not always be land-filled, land-applied, or introduced into the sanitary sewer system due to hazardous waste, pretreatment, or ground water regulations. This is particularly true when catch basins drain runoff from hot spot areas.

H. Effectiveness

What is known about the effectiveness of catch basins is limited to a few studies. Table 1 outlines the results of some of these studies.

Table 1: Pollutant removal of catch basins (percent)

Study	Notes	Pollutant Type/Percent Removed					
		TSS ₁	COD ₁	BOD ₁	TN ₁	TP ₁	Metals
Pitt, et al 1997		32	NA	NA	NA	NA	NA
Aronson et al, 1983	Only very small storms were monitored in this study.	60-97	10-56	54-88	NA	NA	NA
Moineart and Singh, 1994	Annual load reduction estimated based on concentrations and mass of catch basin sediment.	NA	NA	NA	NA	NA	For Cu (3-4% with annual cleaning) (15% w/ monthly cleaning)

¹ TSS=total suspended solids; COD=chemical oxygen demand; BOD=biological oxygen demand; TN=total nitrogen; TP=total phosphorus

I. Cost considerations

A typical pre-cast catch basin costs between \$2,000 and \$3,000. The true pollutant removal cost associated with catch basins, however, is the long-term maintenance cost. A vactor truck, the most common method of catch basin cleaning, costs between \$125,000 and \$150,000. This initial cost may be high for smaller Phase II communities. However, it may be possible to share a vactor truck with another community. Typical vactor trucks can store between 10 and 15 cubic yards of material, which is enough storage for three to five catch basins with the "optimal" design and an 18 inch inflow pipe. Assuming semi-annual cleaning, and that the vactor truck could be filled and material disposed of twice in one day, one truck would be sufficient to clean between 750 and 1,000 catch basins. Another maintenance cost is the staff time needed to operate the truck. Depending on the regulations within a community, disposal costs of the sediment captured in catch basins may be significant. Retrofit catch basin inserts range from as little as \$400 for a "drop-in" type to as much as \$10,000 or more for more elaborate designs.

References

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