Dec. 1, 1992

Sedimentation Basin

Description

Sediment basins are man-made depressions in the ground where runoff water is collected and stored to allow suspended solids to settle out. They are used in conjunction with erosion control measures to prevent off-site sedimentation. They may consist of a dam, barrier or excavation, a principal and emergency outlet structure, and water storage space. Their primary purpose is to trap sediment and other course material. Secondary benefits can include runoff control and preserving the capacity of downstream reservoirs, ditches, canals, diversions, waterways and streams.

Sediment basins are often converted to stormwater basins after the completion of the construction project. It is therefore important to determine from the onset what the ultimate fate of the basin will be and design accordingly.

Other Terms Used to Describe

Settling Basins
Sumps
Debris Basins
Dewatering Basins

Pollutants Controlled and Impacts

Properly designed and maintained sediment basins can be very effective in preventing sedimentation of downstream areas. Coarse and medium size particles and associated pollutants will settle out in the basin. Suspended solids, attached nutrients, and absorbed non-persistent pesticides may break down before proceeding downstream. Because sediment basins also retain water, they may help recharge the ground water.

Sediment basins are not as effective in controlling fine particles (i.e. silt, clay) as sand and other coarse particles.

Application

Land Use
Applicable to all land uses where construction is being done.

Soil/Topography/Climate
Sediment basins are most effective in trapping sandy soils. They are not very effective in areas dominated by clay soils. Therefore, soil tests should be conducted to determine whether a sediment basin will be a feasible means of preventing off-site sedimentation.

As shown in Table 1, below, sand has a low erosion potential, high settlement rate in basins and therefore a low potential for off-site sedimentation in surface waters. Clay has moderate and low erosion potential, low settlement rate in basins, and therefore a high potential for off-site sedimentation.

Table 1

	ERODIBILITY	RUNOFF POTENTIAL	SETTLEMENT RATE
SILTY SOILS silt, silt loam	H	M	L
CLAYEY SOILS clay, clay loam	M	H	L
LOAMY SOILS loam, sandy loam	M	M	M
SANDY SOILS sand	L	L	H

HIGH H MODERATE M LOW L

Source: "Soils and Runoff". Michigan Department of Natural Resources, Land and Water Management Division.

When to Apply

Sediment basins should be one of the first sedimentation control measures to be installed. Apply prior to the start of land clearing on the rest of the construction project and in conjunction with erosion control measures.

Where to Apply

Although erosion control should always be considered first, in those situations where physical conditions or land ownership prevents implementation of erosion control measures, sediment basins offer the most practical solution to the problem.

It is practical and economical to locate sediment basins where the largest storage capacity can be obtained with the least amount of earth work, such as in natural depressions and drainage ways. Do *not* place sediment basins in or immediately adjacent to wetlands.

Relationship With Other BMPs

In general, this practice should be used to help prevent off-site sedimentation. Flow in Diversions and Grassed Waterways are often directed to sediment basins. Dewatering operations may require the use of sediment basins. Energy dissipators should be included at all outfalls to prevent erosion and/or scouring. See the Stabilized Outlets BMP.

Specifications

Planning Considerations:

1. Conduct a site investigation to determine the size of the drainage area and the best location for the basin or basins. Determine soil types. (If the soils are predominantly clay, the basin size required may be larger than practical. With clay soils it is particularly important to make the best use of soil erosion control measures, because sedimentation measures—including sediment basins—do not readily retain clays).

2. Select the site for the sediment based on the natural drainage of the area and the soil type.

   A. Determine the number of basins needed. In some cases, it is more effective to have a number of smaller basins rather than one large basin. This is particularly important in areas with large-grained sediments. In addition, the damage caused by one small basin which fails is much less than the damage caused by one large basin which fails.

   B. The area(s) chosen should be such that runoff can be easily diverted to the basin. The most logical location is usually at the lower end of a drainage area.

   C. The discharge from basins should approximate the pre-development runoff from the site.

   D. Where necessary, the site(s) should also easily accommodate periodic clean-outs.

   E. Do not locate sediment basins in perennial streams or wetlands. In-stream sediment basins are only allowed upon permit by the MDNR, Land and Water Management Division.

3. Determine the ultimate fate of the basin. If the basin is to be a temporary structure which will be filled and stabilized upon completion of the project, then proceed with the design criteria below. If the basin is to become part of a stormwater runoff “treatment train” upon completion, then the design of the basin must be coordinated with the design of the “future use” of the basins. For example, if upon completion of the project the sediment basin will be dredged, stabilized and used as an infiltration basin, then the design criteria in the Infiltration Basin BMP must also be followed. *When two BMPs differ in their design criteria, always use the more conservative of the two designs.*

   If the ultimate fate of the basin is an infiltration basin, avoid using heavy equipment in the area so as not to compact the soils. Soil compaction will decrease the ability of the soil to infiltrate water.

4. Select the appropriate type of basin based on the information below.

There are three classes of sediment basins, as described by the Soil Conservation Service Standards and Specifications. Classification is based on: 1) the maximum drainage area a basin serves; 2) the height of the dam; and 3) the extent of mechanical control devices provided with a basin. While reading the descriptions below, keep in mind the ultimate fate of the basin. If the basin is to be a temporary structure, choose between Class 1 and Class 2 basins. If the structure is to be permanent, then choose between the Class 2 and Class 3 basin and remember that the design criteria for both the sediment basin and the stormwater basin must be met.

<u>Class 1</u> – This is a simple temporary basin, frequently used on construction sites. This basin consists of an excavated area of an earth embankment or dam less than 3 feet high constructed of the soil or stone which is available on the site. These basins can be quickly located and constructed with equipment available on most construction sites. Stabilization of the embankment with vegetation or paving is necessary. Maximum drainage is 20 acres.

<u>Class 2</u> – This is a carefully constructed temporary or permanent sediment basin. It consists of an embankment of selected soil materials constructed under controlled procedures, with provisions for an emergency discharge for stormwater to prevent embankment failure. A class 2 basin is most applicable in situations where significant damage can result to downstream and off-site areas if the basin should fail. Maximum drainage is 30 acres.

<u>Class 3</u> – Class 3 basins have carefully engineered, sophisticated controls and are usually permanent. Both the spillways and embankments are intended to serve as grade stabilization structures which will continue to function as stormwater control measures after construction activities are completed. A Class 3 basin should always be constructed if a basin is to be converted to a permanent stormwater detention site. The maximum drainage is 200 acres.

5. The basins should be stabilized before the upstream area is cleared.

6. Disposal sites for the sediment removed from the basin should be incorporated into the overall site plan. Follow specifications in the Spoil Piles BMP.

7. Sediment basins with dams over six feet in height or more and impounding five or more surface acres, are regulated under the Dam Safety Act, (P.A. 1989, Act 300). Other permits may also be needed.

<u>Design Considerations:</u>
Sediment basins should be designed by registered professional engineers.

The effectiveness in reducing in-stream velocity and allowing suspended solids to settle out depends on the:

A. Surface area of the basin. In general the greater the area, the greater the detention time and the less the flow velocity

B. Size of particles coming into the basin

C. Concentration of particles coming into the basin

D. Rate of flow into the basin

E. Volume. As sediment accumulates, the volume decreases (as does the effectiveness of the basin)

F. Travel distance

Temporary structures should be designed with an expected life of no more than 3 years. Structures which will be in place longer than that should be designed as permanent structures (i.e. have emergency spillways).

Side Slopes:
For safety reasons, the side slopes of sediment basins should be no greater than 2:1 (horizontal to vertical). Use flatter slopes in urban or urbanizing areas for safety and liability.

Shape:
The basin shape should be greater than 2:1 (length to width), and preferably 4:1 to improve trapping efficiency. Baffles can be used to modify the effective flow distance.

Basin Capacity:
At minimum, the sediment capacity of a sediment basin should be equal to the volume of sediment expected to be trapped at the site during the life of the structure, plus additional volume to contain 1 inch of runoff from the entire drainage area. This is equivalent to 3,630 ft^3/acres. For example, if the drainage area is 50 acres, then the basin should be sized to accommodate the soil which can be expected to erode from the 50 acres, plus a volume of 1 inch of runoff from the entire drainage area. For a 50-acre watershed, this would equate to:

The soil expected from the drainage area, plus:

$$50 \text{ acres} \times 1 \text{ inch} \times \frac{1 \text{ foot}}{12''} \times \frac{3{,}630 \text{ ft}^2}{\text{acre}} = 181{,}500 \text{ ft}^3$$

To determine the soil loss expected from the drainage area, use the Universal Soil Loss Equation (USLE) in the Appendix.

If sediment is to be removed periodically, the capacity of the structure can be reduced to not less than a one-year debris accumulation.

Dimensions:
The longer the basin is, the more settling will occur. Therefore, at a minimum, the length of the basin should be no less than 2 times the width, or:

Area of the basin = depth X width X 2 (width)

The length can be effectively “extended” by adding a baffle in the basin perpendicular to the direction of the incoming sediment/water.

Design Problem:

<u>Situation:</u>

Given a drainage area of 50 acres, and having determined that the basin volume needed to control the runoff from this 50 acres is 181,500 ft^3, and having determined—using the USLE—that the volume of soil expected from the site is 7,833 ft^3, determine the appropriate dimensions of the basin. Assume an average depth of 5 feet.

1. First determine that the total volume needed is the volume needed to contain both the sediment and the water. This equates to:

   $181{,}500\ ft^3 + 7{,}833\ ft^3 = 189{,}249\ ft^3$

2. Given that the area of the basin = depth (5 ft.) X W X 2W,

   $189{,}249\ ft^3 = 5 \text{ X } 2W^2$

   $189{,}249\ ft^3 = 10W^2$

   $18{,}924.9\ ft^3 = W^2$

   $137.57\ ft = W$

   and length = 2W = 275.14 ft.

The dimensions are therefore:

a depth of 5 ft, a width of 138 ft, and a length of 275 ft.

Spillway System:

The spillway system should carry the peak runoff from the sediment basin design storm allowing for a 2 foot freeboard. The velocity of the flow discharged from the basin should not exceed that allowable for the receiving water body.

Principle Spillway (Mechanical Spillway):

Class 2 and 3 basins include the design of a principle spillway to allow a controlled discharge of water. The principle spillway normally consists of a vertical pipe (or riser) located at the deepest part of the basin, connected to a horizontal pipe which outlets through the dam or lower slope.

The top of the riser should be at least 3 feet below the top of the dam or crest of the emergency spillway.

The **riser** may be solid or perforated. Perforated risors are surrounded by filter fabric, wire mesh and a mound of well-graded gravel. A trash rack over the top of the riser prevents debris from entering and clogging the spillway.

The horizontal pipe should be provided with **anti-seep collars** to prevent piping along the outside of the pipe.

The **outlet** of the principle spillway for Class 2 and Class 3 basins should be stabilized with riprap. Follow specifications in the Riprap BMP. Although riprap is also recommended for the principle spillway on a Class 1 basins, in most cases a simple filter at the outlet will be adequate. See the Filters BMP.

The **size** of the principle spillway should be large enough to pass 80% of the calculated peak discharge from the drainage area. For Class 1 basins, the peak discharge should be based on the storm frequency equivalent to the lifetime of the project in years, and the Class 2 and Class 3 basins should be designed on a 10-year and 25-year storm frequency, respectively. If the sediment basin will also be used as a stormwater basin then be sure to design the spillway using the appropriate stormwater basin procedure.

Emergency Spillway:
Class 2 and 3 basins require an emergency spillway to protect the embankment by providing an outlet from the basin for runoff volumes which exceed the capacity of the principle spillway. The emergency spillway should be sized to pass the difference in discharge between the design storm frequency and the capacity of the principle spillway. If the basin will be used as a stormwater basin, the emergency spillway should be designed to pass the 100-year storm.

Emergency spillways can be as simple as a slope drain constructed of a half section of corrugated metal pipe, or a riprap channel constructed down the dam slope. The **crest** of the spillway should be three feet above the crest of the mechanical riser and a minimum of two feet above the expected water level for the design storm.

The **cross-section** should be trapezoidal, with side slopes 3:1 or flatter.

The **outlet** of the emergency spillway for Class 2 and Class 3 basins should be stabilized with riprap. Follow specifications in the Riprap BMP. The emergency spillway for a Class 1 basin can consist of a simple berm alongside the outlet to channel water to a stabilized area.

Riser and Barrel:
To facilitate installation and reduce the potential for failure from blockage, the minimum barrel size for corrugated metal pipe should be 8 inches, and 6 inches for smooth wall pipe. The cross-sectional area of the rise at least 1.5 times that of the barrel to improve the efficiency of the principal spillway system.

Embankments:
The embankment should always be constructed with the most stable fill material available. For permanent embankment, selected material may have to be hauled in. Where possible, use soils other than sand. Sandy soils tend to “shift”.

Construction Considerations:

Never build a sediment basin in a perennial stream.

1. Construct the sediment basin before any other land clearing or grading is done. Construct according to the design and following the guidelines below.

2. The natural ground under any proposed embankment or dam should be cleared and stripped of trees, other vegetation and roots following the specifications in the Land Clearing BMP.

The remainder of the basin area should be cleared of trees and larger vegetation to allow easy periodic removal of sediment. Natural grasses and ground cover, however, should be retained to provide stabilization. Also leave a natural <u>Buffer/Filter Strip</u> between the edge of the sediment basin and the sediment basin.

3. Disk or scarify the area where the embankment fill will be placed to allow a good bond between the fill and the existing soil. The placement of fill should be in controlled, uniform layers, and should be compacted using a compacting, or by driving hauling equipment over the area.

4. Dispose of spoils taken from the excavation following procedures in the <u>Spoils Pile</u> BMP. The location of the spoil pile should have been included in the overall design.

5. Stabilize all exposed areas of the embankment by <u>Seeding</u> and <u>Mulching</u> or <u>Sodding</u>. Stabilization of the embankment is particularly important with Class 1 basins since the embankment functions as the spillway.

<u>After Construction:</u>

1. Immediately after the sediment basin is constructed, the top banks of the basin and all surrounding areas should be stabilized with vegetation.

2. If basin size was limited and sediment removal is necessary, it should be done when the sediment has accumulated to no more than 50% of the design depth. It is possible to mark the riser pipe or place a bench mark in the basin to indicate when the basin is half full.

3. Dispose of the sediment in an upland site a way which will not cause erosion, such as in accordance with the <u>Spoils Pile</u> BMP. It is important to test the sediment in areas where toxics are or have been stored, or where toxics can in any way get into the sediment basin. Toxic sediment will have to be disposed in an approved landfill.

4. After the entire construction project is completed, temporary sediment basins should be dewatered following <u>Dewatering</u> BMP, then filled in to conform with the contours of the area. The bulkhead and structures should be removed. Stabilized the area following the <u>Seeding</u> and <u>Mulching</u> or <u>Sodding</u> BMPs.

<u>Maintenance</u>

The property owner is responsible for the maintenance of any sediment basins constructed on their property. Maintenance should be done following any storm and should include:

1. Checking the depth of sediment deposit to ensure the capacity of the basin is adequate for stormwater and sediment deposition, and removing sediment when it has accumulated to no more than 50% of the design depth.

2. Checking the basin for piping, seepage, or other mechanical damage.

3. Checking for the presence of soil caking around the perforated riser pipe, which would prevent proper drainage from the basin.

4. Checking the outfall to ensure drainage is not causing erosive velocities, and to ensure the outlet is not clogged.

Any problems discovered during the maintenance checks should be addressed immediately.

Sediment removed during cleaning should be placed at an upland area and stabilized so that it does not re-enter the drainage course.

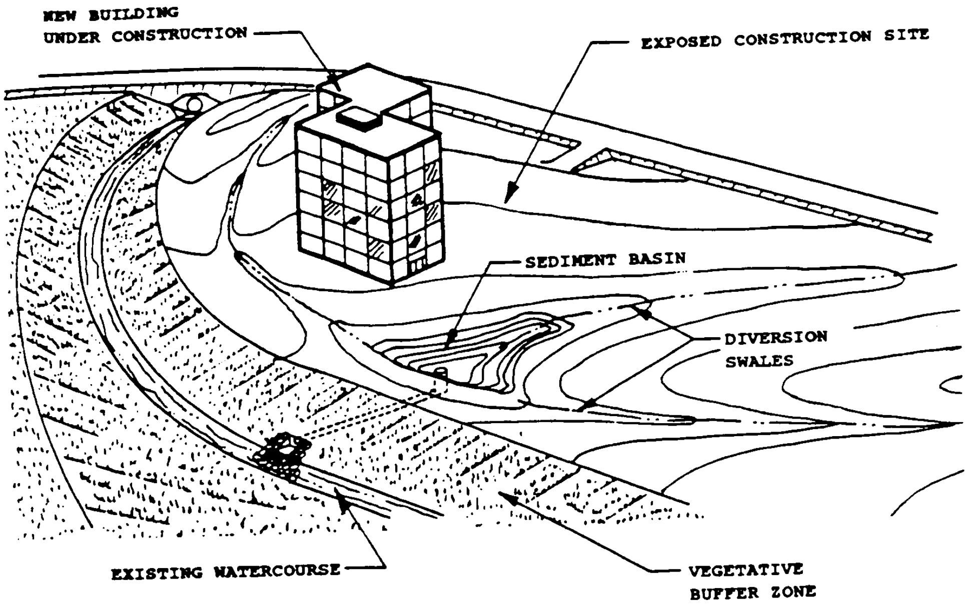
Exhibits

Exhibit 1: Use of Sediment Basins on Construction Sites. Top: Oakland County Soil Erosion Control Manual, Oakland County, Michigan. January 1, 1990. Bottom: "Sediment Basins" (brochure). Michigan Department of Natural Resources, Land and Water Management Division.

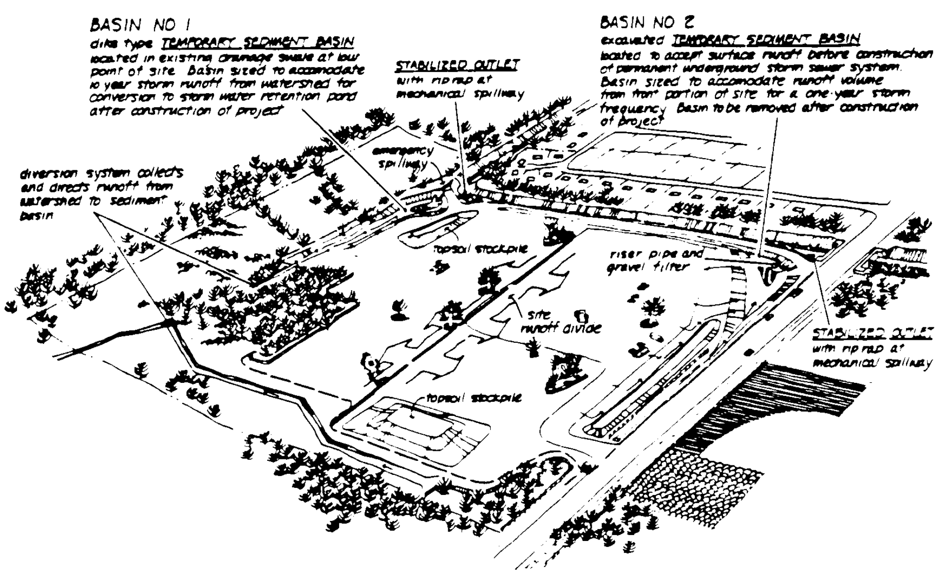
Exhibit 2: Side View of a Sediment Basin. "Sediment Basins" (brochure). Michigan Department of Natural Resources, Land and Water Management Division.

Exhibit 1

Use of Sediment Basins on Construction Sites



Source: Oakland County Erosion Control Manual. Oakland County, Michigan. 1990.

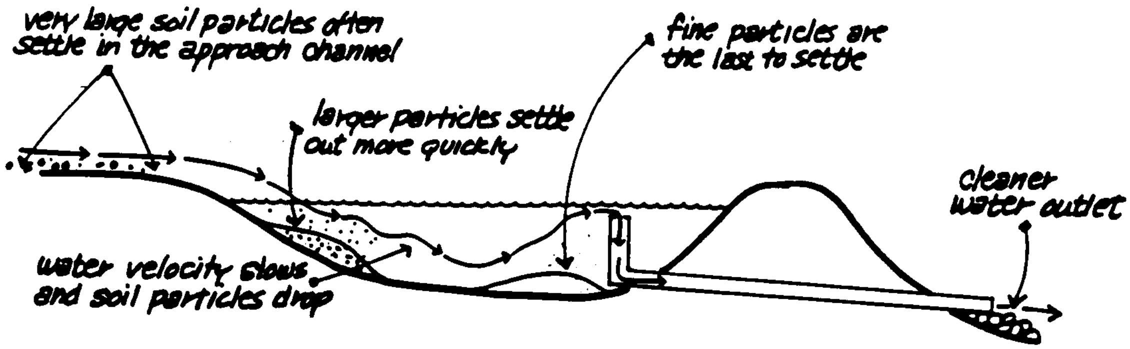


USE OF SEDIMENT BASINS ON CONSTRUCTION SITES
" to collect sediment from storm water runoff "

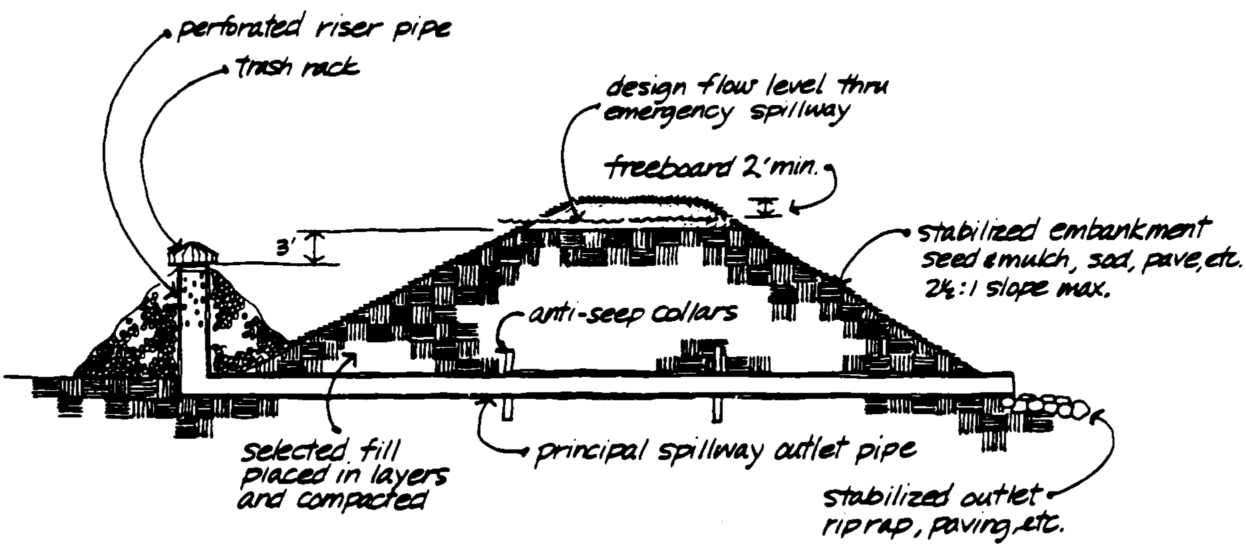
Source: Sediment Basins (brochure). Michigan Department of Natural Resources, Land and Water Management Division.

Exhibit 2

Side View of a Sediment Basin



HOW A SEDIMENT BASIN WORKS



SECTION THRU EMBANKMENT & BASIN CONTROLS

Source: Sediment Basin (brochure). Michigan Department of Natural Resources, Land and Water Management Division.