Sediment Basins and Rock Dams

Sediment basins are used to trap sediments and temporarily detain runoff on larger construction sites

Description

Sediment basins and rock dams can be used to capture sediment from stormwater runoff before it leaves a construction site. Both structures allow a pool to form in an excavated or natural depression, where sediment can settle. The pool is dewatered through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment or through the gravel of the rock dam. The water is released more slowly than it would be without the control structure.

A sediment basin is constructed by excavation or by erecting an earthen embankment across a low area or drainage swale. The basin can be temporary (up to 3 years) or permanent. Some sediment basins are designed to drain completely during dry periods. Others are constructed so that a shallow pool of water remains between storm events.

Rock dams are similar to sediment basins with earthen embankments. These damming structures are constructed of rock and gravel. They release water from the settling pool gradually through the spaces between the rocks.

Applicability

Sediment basins are usually used for drainage areas of 5 to 100 acres. They can be temporary or permanent. Sediment basins designed to be used for up to 3 years are usually described as temporary. Those designed for longer service are considered permanent. Temporary sediment basins can be converted into permanent stormwater runoff management ponds, but they must meet all regulatory requirements for wet ponds.

For EPA Construction General Permit permittees, a sediment basin or its equivalent should accomplish the following for drainage areas of different sizes:

10 or more acres of disturbed area: For common drainage locations that serve an area with 10 or more acres disturbed at one time, a temporary (or permanent) sediment basin that provides storage for a calculated volume of runoff from the drainage area from a 2-year, 24-hour storm, or equivalent control measures, must be provided where attainable until final stabilization of the site. Where no such calculation has been performed, a temporary (or permanent) sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures, must be provided where attainable until final stabilization of the site. When computing the number of acres draining into a common location, it is not necessary to include flows from offsite areas and flows from on-site areas that are either undisturbed or have undergone final stabilization where such flows are diverted around both the disturbed area and the sediment basin. In determining whether installing a sediment basin is attainable, the operator may consider factors such as site soils, slope, available area on-site, etc. In any event, the operator must consider public safety, especially as it relates to children, as a design factor for the sediment basin, and alternative sediment controls must be used where site limitations would preclude a safe design.

For drainage locations which serve 10 or more disturbed acres at one time and where a temporary sediment basin or equivalent controls is not attainable, smaller sediment basins and/or sediment traps should be used. At a minimum, silt fences, vegetative buffer strips, or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions).

Less than 10 acres of disturbed area: For drainage locations serving less than 10 acres, smaller sediment basins and/or sediment traps should be used. At a minimum, silt fences, vegetative buffer strips, or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions) of the construction area unless a sediment basin providing storage for a calculated volume of runoff from a 2-year, 24-hour storm or 3,600 cubic feet of storage per acre drained is provided.

Sediment basins are applicable in drainage areas where it is expected that other erosion controls, such as sediment traps, will not adequately prevent offsite transport of sediment. Whether to construct a sediment basin or a rock dam depends on the materials available, the location of the basin, and the desired capacity for holding stormwater runoff and settling sediment.

Rock dams are suitable where earthen embankments would be difficult to construct and where rocks for the dams are readily available. They are also desirable where the top of the dam structure is to be used as an overflow outlet. Rock dams are best for drainage areas of less than 50 acres. Earthen damming structures are appropriate where failure of the dam will not result in substantial damage or loss of property or life. If sediment basins with earthen dams are properly constructed, they can handle runoff from drainage basins as large as 100 acres.

Siting and Design Considerations

Investigate potential sites for sediment basins during the initial site evaluation. Construct the basins before any grading takes place in the drainage area. For permanent structures, a qualified professional engineer experienced in designing dams should complete the basin design.

Limit sediment basins with rock dams to a drainage area of 50 acres. Limit the rock dam height to 8 feet with a top width of at least 5 feet. Side slopes for rock dams should be no steeper than 2:1 on the basin side of the structure and 3:1 on the outlet side. Cover the basin side of the rock dam with fine gravel from top to bottom for at least 1 foot. This slows the drainage rate from the pool that forms and gives sediments time to settle. The detention time should be at least 8 hours.

Outfit sediment basins with earthen embankments with a dewatering pipe and riser set just above the sediment removal cutoff level. Place the riser pipe at the deepest point of the basin and make sure it extends no farther than 1 foot below the level of the earthen dam. Place a water-permeable cover over the primary dewatering riser pipe to prevent trash and debris from entering and clogging the spillway. To provide an additional path for water to enter the primary spillway, you can drill secondary dewatering holes near the base of the riser pipe, but make sure you protect the holes with gravel to keep sediment out of the spillway piping.

To ensure adequate drainage, use the following equation to approximate the total area of dewatering holes for a particular basin (Smolen et al., 1988):

$A_o = (A_s \times (2h) / (T \times C_d \times 20{,}428)$ where

A_o = total surface area of dewatering holes, ft^2;
A_s = surface area of the basin, ft^2;
h = head of water above the hole, ft;
C_d = coefficient of contraction for an orifice, approximately 0.6; and
T = detention time or time needed to dewater the basin, hours.

In all cases, an appropriate professional should design such structures. The designer should consider local hydrologic, hydraulic, topographic, and sediment conditions.

Limitations

Do not use a sediment basin with an earthen embankment or a rock dam in an area of continuously running water (live streams). Do not use a sediment basin in an area where failure of the earthen or rock dam will result in loss of life or damage to homes or other buildings. Do not use sediment basins in areas where failure will prevent the use of public roads or utilities.

Maintenance Considerations

Routine inspection and maintenance of sediment basins is essential to their continued effectiveness. Inspect basins after each storm event to ensure proper drainage from the collection pool and determine the need for structural repairs. Replace material eroded from earthen embankments or stones moved from rock dams immediately. Locate sediment basins in an area that is easily accessible to maintenance crews for removal of accumulated sediment. Remove sediment from the basin when the storage capacity has reached approximately 50 percent. Remove trash and debris from around dewatering devices promptly after rainfall events.

Effectiveness

The effectiveness of a sediment basin depends primarily on the sediment particle size and the ratio of basin surface area to inflow rate (Smolen et al., 1988). Basins with a large surface area-to-volume ratio are the most effective. Studies have shown that the following equation relating surface area and peak inflow rate gives a trapping efficiency greater than 75 percent for most sediment in the Coastal Plain and Piedmont regions of the southeastern United States (Barfield and Clar, in Smolen et al., 1988):

$$A = 0.01q$$

where A is the basin surface area in acres and q is the peak inflow rate in cubic feet per second.

USEPA (1993) estimates an average total suspended solids removal rate for all sediment basins of 55 percent to 100 percent. The average effectiveness is 70 percent.

Cost Considerations

For a sediment basin with less than 50,000 ft^3 of storage space, the cost of installing the basin ranges from \$0.20 to \$1.30 per cubic foot of storage (about \$1,100 per acre of drainage). The average cost for basins with less than 50,000 ft^3 of storage is approximately \$0.60 per cubic foot of storage (USEPA, 1993). If constructing a sediment basin with more than 50,000 ft^3 of storage space, the cost of installing the basin ranges from \$0.10 to \$0.40 per cubic foot of storage (about \$550 per acre of drainage). The average cost for basins with greater than 50,000 ft^3 of storage is approximately \$0.30 per cubic foot of storage (USEPA, 1993).

References

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