Stormwater Best Management Practice

Sediment Basins and Rock Dams

Minimum Measure: Construction Site Stormwater Runoff Control
Subcategory: Sediment Control

Description

Sediment basins in large drainage areas can capture sediment from stormwater before it leaves a construction site. A sediment basin allows a pool to form in an excavated or natural depression, where sediment can settle.

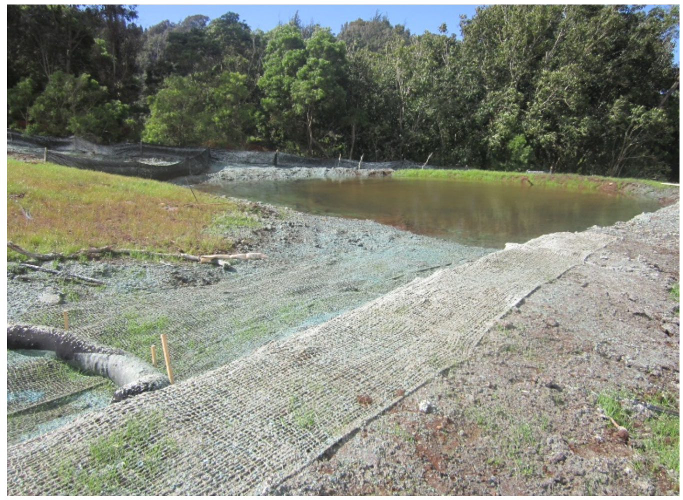
The embankment of a sediment basin can either be compacted soil or a rock dam. When using an earthen embankment, the sediment basin dewaters the pool through a single riser and drainage hole that leads to a suitable outlet on the downstream side of the embankment. Rock dams use rock and gravel as an embankment instead of compacted soil. They gradually release water from the settling pool through the spaces between the rocks. A sediment basin slows the release of stormwater leaving a construction site and reduces the amount of sediment it carries.

Methods for constructing a sediment basin are excavation or erecting an embankment across a low area or drainage swale. A basin can be temporary or permanent. Engineers design some sediment basins to drain completely during dry periods. They construct others so that a shallow pool of water remains between storm events.

Applicability

Sediment basins apply to drainage areas where smaller erosion controls, such as sediment traps, will not adequately prevent off-site transport of sediment. They typically apply to drainage areas of 5 to 100 acres. Drainage areas of less than 5 acres, which generally do not produce enough stormwater to maintain a permanent pool, should use sediment traps. It is possible to convert temporary sediment basins into permanent stormwater management ponds, but they must meet all regulatory requirements for wet ponds.

The choice to construct a sediment basin with an earthen embankment or a rock dam depends on the materials available, the location of the basin, and the desired capacity for holding stormwater 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 if the area will use the top of the dam structure as an overflow outlet. Rock dams are best for drainage areas of less than 50 acres. Earthen damming structures are appropriate where dam failure will not result in substantial damage or loss of property or life.



A sediment basin with earthen embankments stabilized with erosion matting and hydroseed.
Credit: Anthony D'Angelo for USEPA, 2015

Siting and Design Considerations

A sediment basin should be at the lowest point of the site and in an area that maintenance crews can easily access to remove accumulated sediment. Erosion and sediment control permits often require installation of sediment basins before grading or earth disturbance begins, which is a best practice to minimize sediment transport off-site.

Jurisdictional requirements typically specify hydrologic calculations to determine the size of a sediment basin. A typical guideline is to design a sediment basin to store 3,600 cubic feet of water for every acre that drains to the basin (MDE, 2011; WSDOT, 2019). Storage volume

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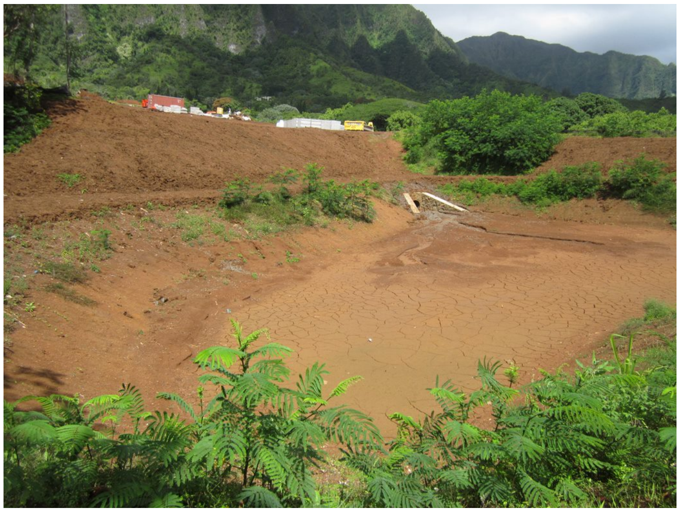
consists of two parts: dry storage (volume of storage below the riser height) and wet storage (volume of storage above the riser). Side slopes should be no steeper than 2 feet horizontally for every 1 foot of elevation change inside the structure and 3 feet horizontally for every 1 foot of elevation change on the outlet side.



A large sediment basin with partially stabilized embankments.
Credit: Anthony D'Angelo for USEPA, 2015

National Pollutant Discharge Elimination System regulations require that for regulated construction sites (disturbing 1 or more acres of earth), unless infeasible, discharges of stormwater from a sediment basin or impoundment must utilize outlet structures that withdraw water from the surface of the water (40 C.F.R. § 450.21[f], 2014).

For sediment basins that will also be permanent stormwater management structures, a qualified professional engineer experienced in designing dams should create the designs.

Sediment Basins with Earthen Embankments

For sediment basins with earthen embankments, the principal spillway is a riser structure. The riser is ideally at the deepest point of the basin, and its height is typically 1 foot below the level of the earthen dam. Most jurisdictions require design engineers to size the riser to handle flow from a specific size of storm. The riser discharges to a barrel, which transports dewatered stormwater through the embankment to discharge from the basin. A properly designed barrel adequately handles flow from the riser and has a watertight connection to the riser.

When using a sediment basin with an earthen embankment, a perforated dewatering pipe or skimmer device that floats on the water surface is advisable to dewater the basin. The dewatering device should have a watertight connection to the base of the riser. If using a perforated dewatering pipe, a water-permeable cover over the pipe prevents trash and debris from entering and clogging the spillway. Design engineers should use erosion and sediment control manuals to determine the size, spacing and total area of the dewatering holes in the pipe. A qualified engineer or other appropriate professional should consider local hydrologic, hydraulic, topographic and sediment conditions when calculating perforations.

Sediment Basins with Rock Dams

Suitable material for a rock dam is well-graded, erosion-resistant stone of mixed size, with a minimum stone size of 12 inches (MPCA, 2019; NCDEQ, 2013). Covering the basin side of the rock dam with fine gravel from top to bottom for at least 1 foot is advisable to slow the drainage rate through the dam and give sediments time to settle.

For erosion protection, construction staff should place a rock apron downstream of the rock dam starting at the toe of the dam. The apron should have a flat slope and at a minimum, a length equal to the height of the rock dam. Construction staff should lay filter fabric under the entire rock dam structure, including the outlet protection, to prevent soil movement.

Limitations

The area draining to a single sediment basin should be no more than 100 acres for a basin with an earthen embankment and 50 acres for a sediment basin using a rock dam. Construction staff should not install sediment basins in a permanent or intermittent stream. Sediment basins are also not suitable for locations where failure of the earthen or rock dam will result in loss of life; cause damage to homes, buildings, or utilities; or prevent the use of public roads.

Most jurisdictions have height maximums for sediment basin embankments. Exceeding these height limitations may trigger more stringent regulatory requirements applicable to dams.

A common cause of structural failure for sediment basins is water piping, a process where water seeps through granular soil and slowly erodes the embankment. Construction staff can reduce the risk of water piping by ensuring that connections between the riser and barrel are tight, they have adequately anchored the riser, they have properly compacted the soil, and they have properly installed anti-seep devices (WSDOT, 2019). For rock dams, using filter fabric at the foundation of the rock structure and along the rock apron for outlet protection reduces the risk of water piping.

Maintenance Considerations

Routine inspection and maintenance of sediment basins is essential for their continued effectiveness. Construction staff should inspect basins after each storm event to ensure proper drainage from the collection pool and to determine the need for structural repairs. They should also inspect dewatering devices and remove any trash and debris they find. Construction staff should immediately repair eroded earthen embankments and immediately replace displaced stones from rock dams. Construction staff should remove sediment accumulation when it exceeds 50 percent of the storage volume.

Effectiveness

The effectiveness of a sediment basin depends primarily on incoming sediment particle size and the ratio of basin surface area to inflow rate (MDE, 2011; MPCA, 2019). Sediment basins are more effective at removing large particles, which settle more quickly than smaller particles such as fine silts and clays. Sediment basins are also more effective when their designs have a large surface area-to-volume ratio. Design engineers can increase sediment removal by adding baffles along the bottom of the basin to slow the flow of water through the basin and trap sediment. Use of a sediment trap as pretreatment before a sediment basin can reduce maintenance requirements for the basin and improve sediment removal rates.

For sites with significant amounts of fine silts and clay soils, adding a treatment chemical—such as a flocculant—can improve performance (MPCA, 2019). If construction staff consider treatment chemicals, they should consult with local permitting authorities to help identify suitable chemicals and ensure the identified chemicals have approval for use.

Estimates from various state agencies show a sediment removal rate of 60 to 80 percent for properly designed sediment basins (Honolulu, 2018; MDE, 2011; U.S. EPA, 2005).

Cost Considerations

When estimating total costs of a sediment basin, construction staff should consider the costs of excavation, embankment materials, piping and pretreatment methods. Excavation costs for a sediment basin range from $3 to $10 per bulk cubic yard (MPCA, 2019; RSMeans, 2019). Raw material costs for an embankment range from $2 per cubic yard for common soils to $9 per cubic yard for granular soils. After incorporating labor and other costs, construction of an earthen embankment costs $15 to $35 per bulk cubic yard of material (MPCA, 2019; RSMeans, 2019). For large stone and gravel, material costs range from $12 to $25 per cubic yard (RSMeans, 2019), with a wide variability due to regional price differences.

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

City and County of Honolulu (Honolulu). (2018). *Effective design of sediment basins* [PowerPoint presentation]. July Construction Stormwater Quality Workshop, Honolulu, HI, United States.

Effluent limitations reflecting the best practicable technology currently available (BPT), 40 C.F.R. § 450.21 (2014).

Maryland Department of the Environment (MDE). (2011). 2011 Maryland standards and specifications for soil erosion and sediment control.

Minnesota Pollution Control Agency (MPCA). (2019). Sediment control practices—Sediment traps and basins. In *Minnesota stormwater manual*.

North Carolina Department of Environmental Quality (NCDEQ). (2013). *Erosion and sediment control planning and design manual*.

RSMeans. (2019). RSMeans data from Gordian [Online database]. RSMeans data from Gordian.

U.S. Environmental Protection Agency (U.S. EPA). (2017). *2017 National Pollutant Discharge Elimination System permit for discharges from construction activities*.

U.S. Environmental Protection Agency (U.S. EPA). (2005). *National management measures to control nonpoint source pollution from urban areas*—Management measure 8: Construction site erosion, sediment, and chemical control (EPA-841-B-05-004).

Washington State Department of Transportation (WSDOT). (2019). *Temporary erosion and sediment control manual*.