Article 59

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Performance of Sediment Controls at Maryland Construction Sites

Sediment traps or basins, common features at most construction sites, represent the last line of defense against soil erosion. Sediment particles that do not settle out in the trap or basin will soon reach a stream. Although sediment traps and basins have been used for decades, research on their actual field performance is scarce. Aren't these traps just "muddy water in, muddy water out, and a lot of money in between?"

Some answers to this question can be found in a study of six sediment traps and basins in Maryland. The construction sites were located in both the piedmont and coastal plain and were well served with erosion control measures (temporary seeding, perimeter controls such as dikes and silt fence, and construction phasing). Soils at each site were silt loams, and each trap or basin served a contributing drainage area of 11 to 35 acres. Construction site runoff entering the basin and traps was heavily laden with suspended sediment (median concentration of 680 mg/l, with a range of 24 to 51,800 mg/l). A particle size analysis indicated that sediment was very fine grained, primarily consisting of silts, clays and colloidal material. Ninety percent of all particles were less than 15 µm diameter, and no particles were found with a diameter >50 µm (coarse silt or fine sand).

Performance monitoring at construction sites is not an easy task. A construction site is never the same from month to month, and each storm creates an ever-changing series of channels and gullies that contribute runoff and

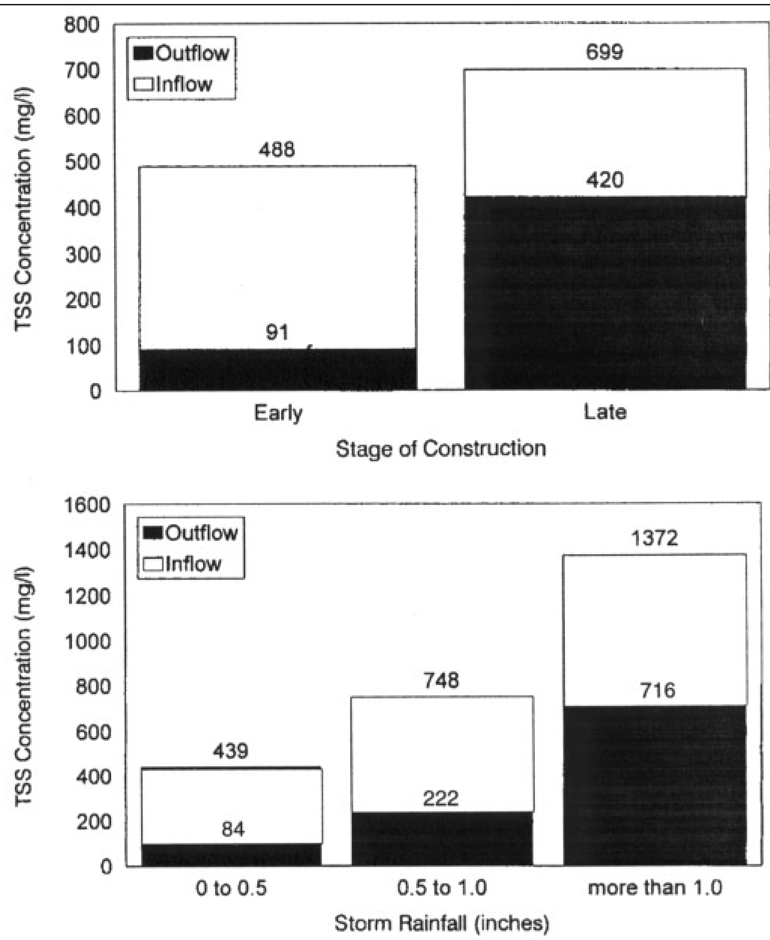

Figure 1: Effects of Construction Stage (a) and Storm Size (b) on TSS Levels in Sediment Traps and Basins

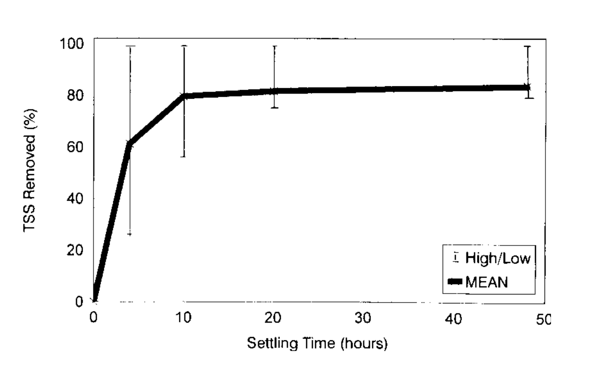

Figure 2: Effect of Settling Time on Sediment Removal Rate—Mean of 12 Settling Column Trials

sediment at multiple points. Thus it is not generally possible to obtain a reliable primary flow measurement to estimate the mass of sediment delivered into the basin or trap. Consequently, an alternative and less powerful sampling protocol had to be utilized. Multiple grab samples were collected at the inlets and the outlet during a large number of storm events. A total of 230 grab samples were taken during nine storm events to compensate for the inaccuracy of the grab sampling approach. Sediment removal was defined as the difference in mean inflow and outflow concentrations during each storm event.

The overall performance of the basins and traps in removing suspended sediment averaged 65% for all nine storm events (range: -273% to +100%). This estimate, however, included numerous small storms which produced flow into the trap or basin but none out of it. When only the storms that produced outflow were considered, sediment removal performance for traps and basins dropped to 46%. Highest removal rates were noted when the construction site was in an early stage of construction, and for smaller storms (<0.75 inches of rainfall) (Figure 1). Poor performance was consistently noted for construction sites in a more advanced stage of construction (particularly after the storm drains had been installed) and during larger storms (0.75 inches of rainfall or more).

A series of 12 laboratory settling column trials confirmed the difficulty of removing the extremely fine-grained construction site sediment particles (Figure 2). While an average of 60% of suspended sediments settled out within the first four hours, additional removal was difficult to achieve. For example, it took an average of six more hours to get the next 18% increment of sediment removal (78% total). Another 10 hours of settling (20 hours total) only removed 2% more sediment (for a total of 80%). Two days of settling in the ideal settling column environment resulted in 90% sediment removal. Particle size analysis indicated that the sediments that still remained in suspension after 48 hours were extremely fine clays and colloidal materials that were highly resistant to further settling. The field study indicated that the outflow from sediment traps and basins was still quite turbid (mean of 200 NTUs) and sediment-laden (mean concentration of 283 mg/l).

The inconsistent performance of sediment controls noted in the study highlights the critical importance of

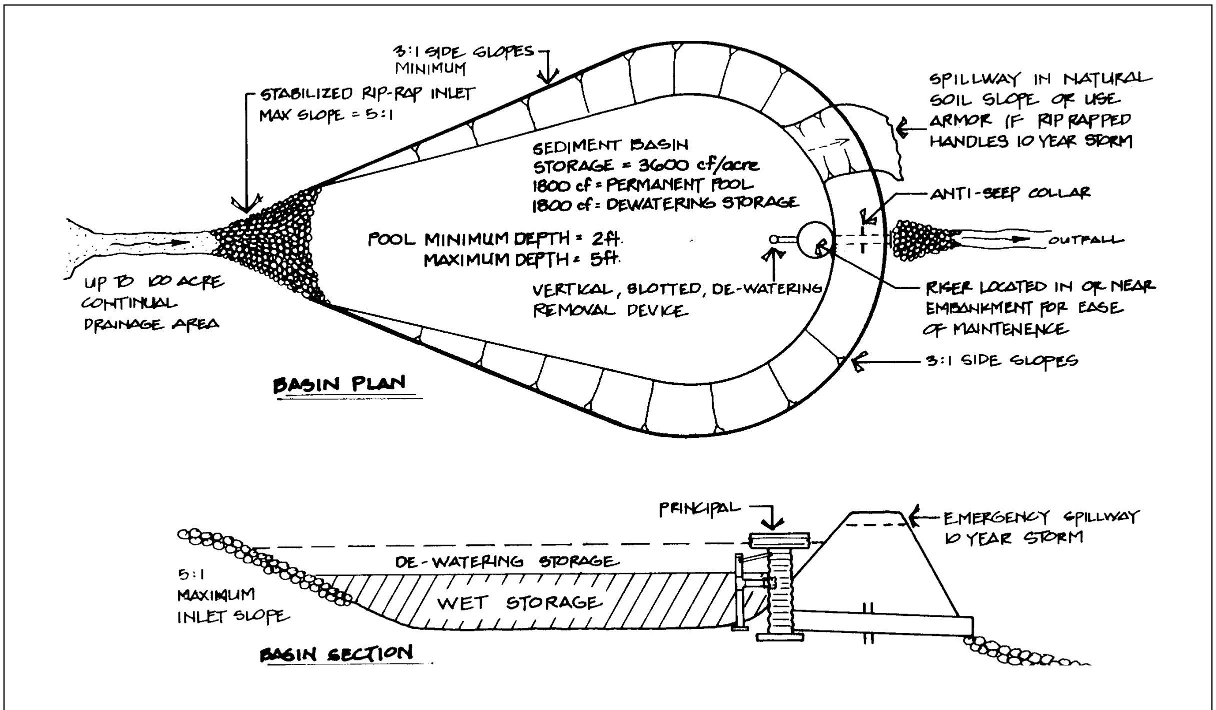

Figure 3: Idealized Schematic of a Sediment Basin Design

preventing erosion from occurring in the first place. Hydroseeding, straw/mulching, slope stabilization and construction sequencing all played a major role in reducing the concentration of sediment delivered to downstream trap or basin.

The study also recommended a series of design improvements for sediment basins. Most notably, the study recommended that storage capacity in basins should be increased from the current 1,800 cubic feet/acre to 3,600 cubic feet/acre. Half of the total storage capacity should be wet, and the remaining half dry (Figure 3). The dry storage is regulated by a vertical dewatering device that extends from the riser. The device can be protected by large mesh hardware cloth. Filter fabric should be avoided as the fine silts and clays quickly clog pore spaces in the fabric. This design should be capable of entirely containing sediment-laden runoff from small storms, and allowing two to six hours of extra detention for the larger storm events as well. These improvements should increase sediment removal when its needed most: during larger storms that occur in the later stages of construction.

References

Schueler, T. and J. Lugbill. 1990. *Performance of Current Sediment Control Measures at Maryland Construction Sites.* Occoquan Watershed Monitoring Lab and Metropolitan Washington Council of Governments. Washington, DC. 90 pp.