Sediment Trapping by Five Different Sediment Detention Devices on Construction Sites

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Abstract. *Sediment pollution from construction sites has been of increasing concern, since the impacts on nearby streams can be severe. Five sediment trapping devices were monitored on construction sites in the Piedmont region of North Carolina to determine their trapping efficiency and the improvement in the water quality of their discharges. For each device, discharges were measured and sampled over periods of 5 to 13 months and the amount of trapped sediment was determined. Three of the devices were basins with rock outlets designed for 10-year recurrence storms with the following differences: one device was over excavated to have a 1 m standing pool, one device had silt fence baffles with weirs, and one device was open and fully drained. The fourth basin with a rock outlet was open and fully drained but sized for a 25-year storm. The fifth device was sized for a 25-year recurrence storm and had a floating surface outlet and solid riser spillways plus porous baffles within the basin. The three rock outlet basins that fully drained retained <40% of the sediment entering them regardless of their variations. However, the rock outlet basin with a 1 m standing pool retained 73% of the sediment for 16 of 17 storms. This could have been higher if the inlet and sides had been stabilized. The larger basin with surface outlets retained over 99% of the sediment it received until the floating outlet became mired in sediment, reducing the efficiency to 76%. Average discharge water quality was the highest for the standing pool and surface outlet designs, but all of the devices had very high turbidity and total suspended sediment (TSS) during peak flows. Maximum values for turbidity and TSS ranged from 16,000 to >30,000 nephelometric turbidity units (NTU) and from 20,000 to 168,000 mg L^{-1}, respectively. There was a high correlation between turbidity and TSS among all the discharge samples. This study suggests that typical sediment traps are inadequate for retaining construction site sediment using current design criteria. It is possible, however, to have very effective sediment retention using recent advances in design.*

Keywords. *Baffles, Efficiency, Sediment basin, Sediment trap, Total suspended solids, Turbidity.*

Sediment trapping devices are commonly installed on construction sites to provide temporary pooling of runoff to allow suspended sediment to settle before the water is discharged. However, little information is available on their effectiveness on active construction sites, particularly as affected by modification of the trap or outlet. Schueler and Lugbill (1990) found that an average of 46% of the solids in water entering sediment trapping devices was removed, depending on soil characteristics and the severity of the storm event. Peak total suspended sediment (TSS) concentrations during more intense rain events exceeded the median value effluent concentration of 680 mg L^{-1} by fourfold. The devices in the study were monitored only for a short period of time, however, and consisted of one composite sample per storm event. Line and White (2001) found the trapping efficiency of traps located in the Coastal Plain and the Piedmont of North Carolina was 69% and 59%, respectively. These devices were monitored for an extensive period (13 to 43 events), and individual samples were taken throughout each storm event.

A number of sediment trapping devices design factors have been studied to optimize sediment trapping. Length to width ratio affects the dead storage volume within a basin (Chen, 1975; Griffin et al., 1985), with a minimum length to width ratio of 2:1 being recommended by numerous authors (Haan et al., 1994; Mills and Clar, 1976) and in most design manuals (e.g., NCDENR; 2006). However, these structures are less effective when swift, turbulent water moves straight through them to the outlet, commonly referred to as short-circuiting. Solid baffles of various designs, usually located near the inlet, have been recommended to eliminate short-circuiting in sediment basins (Goldberg et al., 1986; Haan et al., 1994). An alternative system of porous baffles has been shown to greatly increase basin trapping efficiency by reducing turbulence and distributing the flow more evenly (Thaxton et al., 2004; Thaxton and McLaughlin, 2005). These are now required in all sediment traps and basins in North Carolina.

The principal spillway for a basin is also a factor in performance efficiency. The previously mentioned field study of typical sediment basins found that basins with rock outlets trapped 59% to 69% of the sediment entering the basins over a period of 20 months (Line and White, 2001). Under controlled conditions, engineered dewatering methods have had sediment capture rates of 88% or better by using perforated risers (Fennessey and Jarrett, 1997; Edwards et al., 1999) or a floating skimmer (Millen et al., 1997). The skimmer pro-

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vided the highest sediment capture rate. Trapping efficiency has been demonstrated through modeling to be significantly reduced with full water column or bottom dewatering compared to surface outlets (Ward et al., 1979). In North Carolina, the primary spillway has usually consisted of gravel and stone, although surface outlets are now being encouraged (NCDENR, 2006).

The ability of sediment detention devices to retain sediment has clearly not been well documented, particularly on active construction sites, but the information available suggests that it is relatively low. The purpose of this study was to determine discharge water quality and sediment retention for sediment detention devices of different designs on active construction sites.

Methods

The sediment traps and basins in this study were located on a North Carolina Department of Transportation (NCDOT) highway construction site in Johnston County, North Carolina, and on a private development site in Durham County, North Carolina. Both are in the Piedmont region of the central part of the state. The NCDOT site was adjacent to a sensitive watershed due to the presence of endangered fresh water mussels in Swift Creek, which runs through much of the project. As a protective measure, devices draining to the creek were designed and built based on a 25-year recurrence storm event, as opposed to the standard 10-year event design. These 25-year storm devices are much larger in overall volume and surface area. The basin dimensions were designed based on the following equation:

$$A = 435*Q_p \tag{1}$$

where

A = the surface area of the basin needed by design for given area watershed (cubic feet)

Q_p = peak flow for storms of X recurrence (cubic feet per second)

X = Storm recurrence, usually 10 or 25 year.

The above equation came from the state design manual (NCDENR, 2006) based on the work of McBurnie et al. (1990), which suggested that this design would provide a trapping efficiency greater than 75% for typical soils. The 24 h rainfall totals for this area of the Piedmont are 125 and 198 mm for the 10-year and 25-year recurrences, respectively. The depth was calculated to attain a minimum of 1,800 cubic feet per disturbed acre (112 m^3 ha^{-1}) in the basin watershed. The resulting basin dimensions and other characteristics are shown in table 1.

The primary outlet for the skimmer basins (SkB) was a Faircloth skimmer (Faircloth Skimmers, Hillsborough, N.C.) with a 50 mm orifice attached to the bottom of a 1.5 × 1.5 × 1.5 m concrete riser box (fig. 1). A 0.61 m diameter opening in the top of the box served as the secondary outlet, although it handled most of the flow from the basin during typical storms. This basin was designed to be used as a hazardous spill basin after highway construction was complete. The basin can be sealed off with a sluice gate in the event of a chemical spill on the highway. The sides of the basin had 2:1 slopes, which were stabilized with grass and excelsior erosion control blankets. Flow out of the basin was monitored in the 0.38 m diameter concrete pipe draining the riser box. The sampler was programmed to collect samples based on flow calculated from water levels using the Manning equation. An ISCO 6700 series sampler (ISCO, Lincoln, Neb.) with a bubbler module was installed at the inlet of the pipe and programmed to take samples during storm events. All of the devices monitored used the same system, adjusted for the pipe or weir where monitoring was conducted. The sampler contained 24 (1000 mL) bottles in which four (200 mL) samples were composited. An ISCO 674 rain gauge with a tipping bucket was attached to the sampler and used to monitor rainfall amounts.

A standard trap (10ST) was also constructed and monitored at the NCDOT site (fig. 2). This trap was a silt trapping device installed with vertical walls. These types of traps typically have vertical walls, no inlet protection, and a combination of washed gravel (d_{50} = 12 to 18 mm) and stone (d_{50} = 0.23 m) for the weir outlet. The dimensions of this trap were calculated based on 51 m^3 (1800 ft^3) per 0.4 ha (1 acre) of drainage, resulting in dimensions of 16 × 8 × 1 m (length, width, depth). The 10ST was built specifically for our research to enable us to study the efficiencies of a typical 10-year storm standard trap, and it emptied into the existing 25-year design trap to avoid regulatory issues. The outlet was a 2 m wide rock weir comprised of stone with a layer of washed gravel placed on the inside face of the rock dam. We installed a 90° V-notch weir below the rock weir with dimensions 1.2 × 0.8 m (length, height). Plywood side walls were installed on each end of the weir and buried in the side walls of the dam to prevent erosion along the edges and to maintain flow through the weir. The plywood was buried 0.15 m into the ground with the V-notch 0.10 m above ground. This left a total of 0.36 m that made up the head of the weir. An ISCO 6712 sampler with a bubbler module was then installed and programmed to measure flow and obtain samples at the outlet of the trap.

Table 1. Summary of basin and trap characteristics.

	Skimmer Basin (SkB)	Standard 10-Year Trap (10ST)	Standard 10-Year Trap w/ Standing Pool (STSP)	Standard 25-Year Trap (25ST)	Standard Trap w/ Silt Fence Baffles (STSFB)
Baffles	Porous coir	None	None	None	Silt fence
Outlet	Skimmer	Rock weir	Gravel/drop inlet	Rock weir	Rock weir
Sizing	25 year	10 year	10 year	25 year	10 year
Side walls	2:1, blanket + grass	Vertical	Vertical	Vertical	2:1, grass
Flow measurement	Pipe	V-notch weir	Pipe	V-notch weir	Rectangular weir
Design drainage area (ha)	1.4	1	0.8	1.2	0.60
Dimensions (length, width, depth, m)	42 × 21 × 1	16 × 8 × 1	15 × 5 × 1	28 × 14 × 1	22 × 11 × 1
Design peak flow (m^3 s^{-1})	0.45	0.23	0.18	0.42	0.15

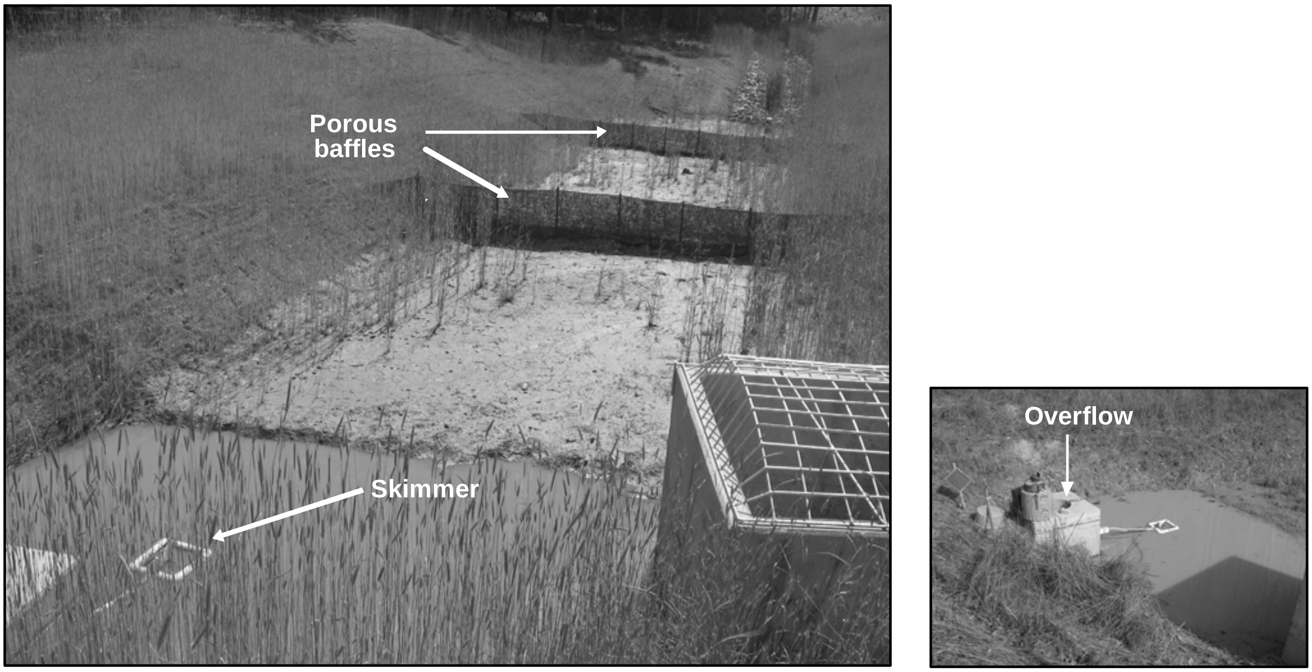

Figure 1. Skimmer basin on 15 November 2006. The skimmer is floating just beyond the smaller of the riser structures and is attached to the bottom of it. Most of the water came into the basin in a culvert at the far end.

Figure 2. Standard 10-year trap (10ST) on 12 December 2005, when the water was less than 0.3 m deep.

A standard trap with a standing pool (STSP) was also selected for monitoring (fig. 3). It had vertical walls and was excavated 1 m below grade to create a standing pool. This essentially transformed the trap into a riser basin with a 1 m high solid riser, with overflow through a gravel inlet protection device and into a storm drain. We monitored the flow at the outlet of the storm drain, which was a 0.38 m concrete pipe. An ISCO 6700 Series sampler with a bubbler module was installed at the outlet of the pipe and programmed to measure flow and collect samples during storm events.

Figure 3. Standard trap with a standing pool (STSP) on 26 April 2006. Monitoring was conducted at the end of the pipe draining the drop inlet in the foreground.

Figure 4. Standard trap with silt fence baffles (STSFB) on 6 June 2005.

Figure 5. The 25ST device on 14 June 2006, during a major rainfall event.

A standard trap with silt fence baffles (STSFB) was also monitored during this study (fig. 4). This trap was located on a private construction site approximately 30 km west of the NCDOT site, in Durham, NC. Aside from the baffles, it differed from the other traps in that it had 2:1 sloping walls covered with temporary ground cover. We installed a plywood rectangular weir with end contractions on the back side of the rock weir. The weir was 2.4 m long and 0.8 m tall. The weir bottom was buried 0.15 m into the ground, with 0.10 m from the ground to the weir notch. This left a total of 0.51 m for the head of the weir. An ISCO 6712 sampler with a bubbler module was installed and programmed to take samples when flow was initiated An ISCO 674 rain gauge was attached to the sampler and used to monitor rainfall amounts.

One additional trap (25ST), sized for a 25-year recurrence storm, was monitored using the same V-notch weir installation as the ST (fig. 5). However, the final survey of accumulated sediment (described below) was corrupted and unusable for calculating the amount of sediment deposited, and this device was removed before we discovered this problem. We included the data from the discharge monitoring, but we could not calculate the trapping efficiency for this trap.

Site Surveys and Analysis

All devices being monitored were surveyed using a Sokkia Total Station (Series 30R, Sokkia Corp., Olathe, Kans.). This instrument provided three-dimensional coordinates of points within the basin, including the walls and deposition or erosion areas. An initial survey of each trap or basin provided the volume of the basin at the time monitoring was initiated. In most cases, the basins were surveyed after they were installed and before additional changes occurred to the original dimensions due to erosion or deposition. Surveys were conducted when major changes were observed, i.e., sediment removal to maintain the device, and at the end of discharge monitoring.

To determine the volume changes in each basin, an AutoCAD program (AutoCAD Land Desktop, Autodesk, Inc., San Rafael, Cal.) was used to develop a three-dimensional map of each basin for each survey. The maps were then checked for accuracy by visual inspection of the images for unusual shapes or depths of deposited sediment accumulation that did not match other numbers within the same survey. The basins were also frequently photographed, and these images were used for further confirmation of the survey results. A volume report was generated from each survey, and the net change in volume was calculated by simply subtracting the volumes from each volume report.

Deposited sediment in the devices was sampled at the time of the last survey in order to determine bulk density and particle size distribution. Three samples were obtained at points near the inlet, middle (halfway between inlet and outlet), and within 1 m of the outlet. Samples were collected by inserting metal cylinders (0.0001374 m^3) into the sediment. Multiple cylinders were taped together as a column and carefully inserted into the sediment deposit until reaching the original basin bottom, which was noticeably more resistant than the deposits. The sediment cores collected represented all sediment deposited in the basin over the length of the monitoring time. Sediment sources for each device were changing due to earth moving activities during our monitoring, so we were not able to characterize incoming sediment.

Laboratory Analysis

Runoff samples were measured for turbidity using the Analite nephelometer (model 152, McVan Instruments, Melbourne, Australia). Each sample was shaken for 10 seconds and a reading was taken 30 seconds later. Because turbidity continuously dropped as sediment settled, a set time provided a standard for all readings. Samples with turbidity over the instrument limit of 3,000 NTU were subsampled and diluted to bring the reading down to <3,000 NTU, and then that value was multiplied by the dilution factor. We did not make dilutions greater than 10:1 to avoid subsampling errors, so samples that remained above 3,000 NTU after a 10:1 dilution were entered as >30,000 NTU. For statistical purposes, they were calculated as 30,000 NTU. Turbidity readings from the nephelometer were corrected against formazin turbidity standards (HF Scientific, Ft. Myers, Fla.) using a linear regression. This correction was performed each day for the samples analyzed that day.

Total suspended solids (TSS) was determined by the filtration method (Clesceri et al., 1998). Subsamples (50 mL) were removed by pipette from all parts of the sample volume while it was rapidly stirred on a magnetic stir plate. The subsample was filtered through 90 mm diameter, 1.5 μm preweighed filters (Environmental Express, Mt. Pleasant, S.C.). The filters were then dried in an oven at 103°C to 105°C and weighed.

The sample cores taken from within the devices were dried at 103°C to 105°C until a constant weight was found. The samples were then weighed and the bulk density calculated. Particle size analysis was also performed on the samples collected in cores using the hydrometer method (Gee and Bauder, 1986).

Results and Discussion

One observed difference between the devices was the rapid erosion of the walls of the three standard traps that had vertical walls. The unprotected inlet of the four standard traps was also a major source of sediment. The vertical walls and unprotected inlets resulted in a considerable amount of sediment in the traps being generated from these areas. For example, the STSP inlet gully, evident in figure 3, contributed approximately 1,500 kg of sediment to the trap. In contrast, flow into the skimmer basin occurred through a culvert or through 0.3 m slope drains with outlets stabilized with rock, so little erosion occurred at its inlets. The skimmer basin also had 2:1 sloped side walls stabilized with matting and grass, which generated much less sediment. As a result, the differences in trapping efficiencies were an integration of the differences in hydraulic function and the inherent stability of the devices.

Between 11 and 35 storm events were monitored among the five devices, with total precipitation for each rain event ranging from 0.8 to 221 mm. The rate of discharge for each site varied, but the SkB had a noticeably lower overall rate of discharge due to the controlled release of water through the 50 mm orifice. Because of its larger size and the low rate of discharge through the skimmer until the basin began to discharge through the riser, there was also much more storage occurring.

The amount of discharged sediment varied widely for each storm, from as little a 1 kg to as much as 68,360 kg, or 1 to 48,830 kg ha^{-1} based on the design area for each device (table 2). The highest discharges occurred in the STSP trap during an October storm (30 mm), and we calculated discharge rates and trapping efficiency both with and without that event because it represented the majority of the sediment discharged from that trap. There was no evidence of sampler problems or other errors. The increase in sediment could have been the result of grading activity in the watershed, but the sediment discharge was unusually high for that particular trap during that particular storm. The STSFB discharged more than 45,000 kg of sediment during the monitoring period, equivalent to 56,000 kg ha^{-1} over a period of eight months. The traps retained 34% to 45% of the sediment that entered them (table 3), efficiencies even lower than those reported by Line and White (2001).

The overall amount of sediment entering to the traps ranged from about 8,000 kg to over 110,000 kg, yet the efficiencies were very similar. As mentioned above, one event for STSP accounted for 81% of the total sediment discharged from this device even though the rainfall for this event was only 30 mm over 24 h. There were four events with more rainfall but much less sediment, suggesting that either activities in the watershed or the obvious erosion of the unprotected inlet of the basin produced the unusually high sediment levels (fig. 6). Leaving out the one major sediment discharge event for STSP increased efficiency to 73%, which may be more realistic for this design given the benefits of a standing pool and surface outlet (Fennesey and Jarrett, 1997). This also closely matched the 75% trapping efficiency calculated by McBurnie et al. (1990). The STSFB device actually had a reduction in trapping efficiency after the sediment was removed. The sediment removal was only partial, however, and left the trap highly disturbed with steep side slopes. This probably mobilized a considerable amount of sediment previously deposited on the bottom and enhanced erosion of the structure sides and bottom.

The SkB was extremely efficient, retaining more than 99% of the sediment entering it from 20 March 2006 to

Table 2. Summary of monitoring results for five devices.

			Storm Event Results			
Device	Monitoring Period	Total Rain Events	Flow ($m^3 s^{-1}$)	Rainfall (mm)	Sediment Discharged (kg)	Solids Lost from Drainage Area (kg ha^{-1})
SkB	20 March 2006 to 18 April 2007	35	0.0015-0.02	3-46	1-68,360	1-48,830
10ST	7 October 2005 to 23 February 2006	18	0.02-0.035	0.8-38	2-1,460	1-1,460
STSP	7 April 2006 to 2 March 2007	17	0.002-0.075	10-221	2-17,620 (2-3,040)[a]	3-29,360 3-5,070[a]
25ST	22 October 2005 to 22 August 2006	29	0.001-0.048	1-65	5-3,270	4-2,730
STSFB	1 July 2005 to 8 February 2006	11	0.002-0.055	6.4-45.5	66-10,080	110-16,800

[a] Without the October storm event.

Table 3. Sediment balance and trapping efficiency for four sediment control devices.

	SkB		10ST, 16 Rain Events	STSP, 17 Rain Events	STSFB	
	33 Rain Events	2 Rain Events (skimmer on bottom)			6 Rain Events	5 Rain Events (after cleanout)
Sediment entered (kg)[a]	384,200	459,100	8,000	33,200	41,600	32,900
Sediment lost (kg)	1,200	109,300	5,200	21,800	22,900	22,200
Sediment captured (kg)	383,000	349,900	2,800	11,400	18,700	9,700
Retention (%)	99.6	76	35	34/73[b]	45	31

[a] Numbers computed by taking total amount of sediment leaving the device, converting the volume change within the device over time to kg, and adding the two together.
[b] With/without the October event, which generated most of the sediment discharged.

Figure 6. The STSP showing significant erosion at the unprotected inlet.

26 February 2007. The combination of the larger basin size, porous baffles, and surface outlets, along with a more stable device overall (i.e., 2:1 sloping walls, excelsior matting to help establish vegetation), was clearly effective in retaining sediment. However, between 26 February 2007 and 19 April 2007, the results change dramatically when the skimmer became mired in the sediment that had accumulated within the basin. This brought the trapping efficiency down to 76% for the monitoring period between February and April 2007. There was little sediment discharging from SkB until the basin filled with sediment, which both mired the skimmer in the bottom and nearly buried the porous baffles. The basin discharged 1,200 kg of sediment during the period when the skimmer was freely floating, compared to 109,300 kg discharged once the skimmer was stuck in the bottom. Once the skimmer was lodged in the bottom, it became a bottom outlet that discharged high concentrations of sediment. Normal maintenance involving removal of the accumulated sediment from the basin would have prevented this problem. The reason the retention efficiency was as high as 76% was that the 50 mm opening restricted flow, so most of the storm discharge exited over the top of the riser.

The incremental contribution of each design change from the small traps to the large skimmer basin was not determined. Rauhofer et al (2001) found that increasing the basin size almost three times reduced sediment discharge 15%, while changing the outlet of the smaller basin from a perforated riser to a skimmer reduced sediment discharge by 30%. The larger basin with a skimmer had 60% less sediment discharged compared to the smaller basin with a perforated riser. The 25ST may have been relatively efficient, but the survey data problem prevented us from accurately assessing it. Based on photographs, we estimated the apparent sediment deposited and calculated a trapping efficiency of over 90%. This is only an estimate, but it appeared to be the most efficient of the rock outlet basins. While considerably larger than standard traps, and therefore likely to be more efficient, this trap also did not receive the design flow from 1.2 ha because of a haul road that diverted a portion of the watershed runoff to another device. This is a common occurrence on construction sites.

The quality of the discharged water ranged widely in both turbidity and TSS (tables 4 and 5). The lowest mean values were found in the STSP, followed by the SkB, even though the former discharged much more sediment. This is likely because the STSP remained full of water between storm events, so runoff quickly displaced the cleaner trap water into the riser at the start of an event. As a result, the first part of the hy-

Table 4. Turbidity in discharges from the four devices monitored.

Device	Turbidity (NTU)			
	Min.	Max.	Median	Mean
SkB	0	>30,000[a]	410	1,070
10ST	380	16,000	1,460	2,090
STSP	18	29,090	90	130
25ST	330	29,800	3,170	4,410
STSFB	450	>30,000[a]	11,210	12,640

[a] Maximum value measurable by turbidimeter with maximum dilution.

Table 5. Total suspended solids in discharges from each device.

Device	TSS (mg L^{-1})			
	Min.	Max.	Median	Mean
SkB	2	97,760	170	1,040
10ST	84	20,100	430	1,080
STSP	10	168,160	34	79
25ST	120	47,730	870	3,810
STSFB	134	43,150	6,970	8,420

Table 6. Relationship between turbidity and TSS for each device and for all data combined.

	SkB	10ST	STSP	STSFB	All
N	454	183	212	83	849
r^2	0.80	0.77	0.92	0.80	0.76
Slope	0.456	0.610	1.26	0.820	0.82
Intercept (mg L^{-1})	-45	-197	-348	829	-355

drograph was likely water that had been stored in the trap and that would have much lower turbidity. This would also explain some of the very low minimum values for both STSP and SkB. The STSFB trap had very high turbidity and TSS in its discharge compared to the other devices, which was likely due to the combined effects of a different soil and poor trap maintenance. This trap was located in the Triassic Basin, having soils with expanding clays that are more difficult to settle. Sediment accumulations in this trap were often above the first baffle and well into the next two baffles, reducing their effectiveness and sending flows through the rock dam early in the storm events. The 10ST had the poorest discharge water quality among the devices at the DOT site. Daniel et al. (1979) and Wolman and Schick (1967) reported similar values for TSS in construction site runoff, with peaks of up to 60,000 mg L^{-1} and 150,000 mg L^{-1}, respectively.

The relationship between turbidity and TSS was strong for each device and among all the devices (table 6). The relationship was substantially different among the devices, as indicated by the slopes and intercepts, even among the three devices near each other (SkB, 10ST, STSP). These three devices received runoff from combinations of cut and fill areas, so the surface materials were likely quite different and constantly changing. Measuring turbidity is much faster and less expensive than TSS, but it appears to be site-specific. Relationships will need to be established for each site in order to use a regression equation to predict TSS. In spite of the differences between the turbidity-TSS relationships among devices, when all of the data were combined, the correlation was still fairly strong (fig. 7). A linear relationship is shown because it had as high a coefficient of determination as any curvilinear relationships we tested.

Previous work has shown that porous baffles substantially reduce velocity and turbulence in sediment basins, and as a result the larger particles are trapped closer to the inlet

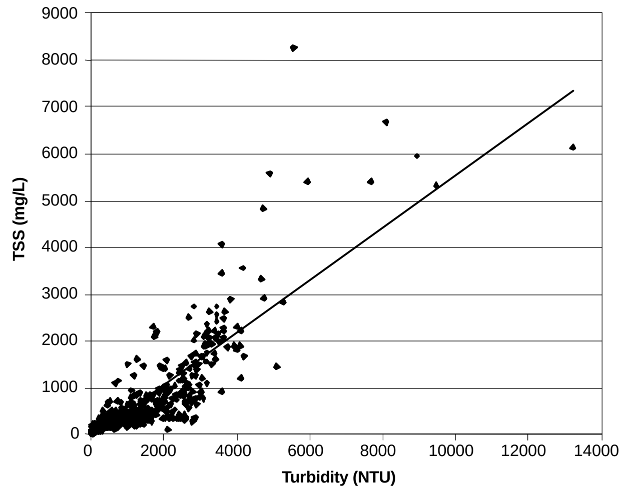

Figure 7. Linear relationship between turbidity and TSS (mg L^{-1}) for all data collected. Statistical results are presented in table 6.

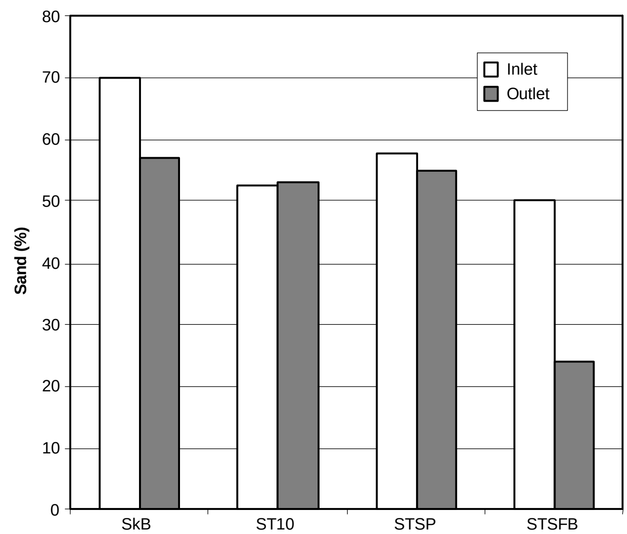

Figure 8. Sand content in sediment accumulated near the inlet and outlet in the devices at the end of the monitoring period.

(Thaxton, et. al., 2004; Thaxton and McLaughlin, 2005). Reduced sand content from inlet to outlet was evident in the STSFB and SkB devices, both of which had baffles, but not in the STSP and 10ST (fig. 8).

The lack of change in sand content in the STSP was likely due to short-circuiting flows that pushed the sand through this open basin, as was demonstrated by Thaxton and McLaughlin (2005). The 10ST also had short-circuiting issues because of the location of inlets positioned directly adjacent to the rock weir outlet. Placing the sediment trap in the diversion ditch on the edge of the site, such as in the 10ST case, is a common practice but tends to lead to short-circuiting. Persson et al. (1999) found this configuration of inlet and outlet was the least hydraulically efficient of 13 designs modeled. In addition, the instability of the devices, with erosion occurring at the inlet and sides during the monitoring period, could have contributed a relatively constant source of sediment with the same particle size distribution. In both the SkB and STSFB devices, the side slopes were graded and stabilized, so most of the sediment came into the basin with the runoff rather than being generated within the basin itself.

Conclusions

The effectiveness of sediment control devices was studied on construction sites to determine the effects of different designs and conditions. Sediment trapping and discharge data strongly suggested that commonly used designs are relatively ineffective. The three devices with rock dam outlets retained <45% of the sediment entering the traps and discharged up to 54 mt ha^{-1} over eight months of monitoring. In contrast, the SkB device, with surface outlets, stable sides and inlets, and porous baffles, retained more than 99% of the sediment entering it. This efficiency dropped considerably when the floating outlet became mired in sediment, resulting in discharge from the bottom. There were indications that a standing pool could improve the efficiency of sediment traps, but without baffles, short-circuiting may reduce effectiveness. While the SkB retained most of the sediment entering it, the discharges were still relatively turbid (1,070 NTU avg.) and contained considerable TSS (1,040 mg L^{-1} avg.). It is likely that the remaining suspended materials are very fine and will not settle by gravity alone under typical retention times. However, the improvements made in sediment retention in general will significantly reduce the impacts of land disturbances from construction activity on water quality in nearby streams.

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