TESTING SUMMARY

Preliminary Field Monitoring Results
Madison, Wisconsin

This summary was prepared by Stormceptor® and reviewed for consistency by the Wisconsin Department of Natural Resources (DNR) and the United States Geological Survey (USGS). The review does not constitute endorsement by either DNR or USGS. These results are preliminary and presented in good faith based on the data available to-date. The results may be subject to change pending further data analysis and report finalization.

A Stormceptor STC 6000 was installed at an existing public works yard in Madison, Wisconsin in May 1996. The site was selected for retrofit due to the high potential for pollutant loadings and lack of stormwater quality control. The unit drains 4.3 acres (1.74 ha) of the yard, all highly impervious. The works yard is used for yard waste drop-off, fueling, storage and cleaning of city vehicles and storage of sand and salt for road de-icing. Pictures of the site are shown below.

The picture on the left was taken in February 1998 showing used snow/sand piles. The person in the picture is standing on one of the catch-basin inlets to the storm drain system.

The picture below shows sand piles on the site in May 1996 during the installation of the unit.

DNR and USGS monitored the Stormceptor from August 1996 to April 1997. A summary of the results is provided below. A full copy of the report should be available from either DNR or USGS in the spring of 1999.

Forty-five events were fully monitored over the nine-month monitoring period while another sixteen were partially monitored. Flow proportional sampling was conducted upstream of the unit, at the by-pass weir, and in the outlet pipe from the lower chamber of the Stormceptor.

The following summary highlights the results from this study.

The runoff depth for the majority (80%) of events was less than 0.5" (12.5 mm). Approximately 30% of the events (13) recorded runoff volumes greater than 0.39" (10 mm). Three events occurred with runoff depths greater than 0.75" (19 mm). The largest event recorded produced 1.9" (48 mm) of runoff. The Stormceptor treated approximately 91% of the runoff and by-passed the remaining 9% of runoff. Discrepancies were observed between the monitored rainfall depths and runoff volumes. Based on the drainage area of 4.3 ac (1.74 ha) there was approximately 40% more runoff than precipitation over the monitoring period. The winter/spring error is exaggerated due to on-site snow piles from ploughed roads and the inability of the tipping bucket rain gauge to accurately measure water equivalent for snowfall on the site itself. Reviewing the fall rainfall data (Aug-Oct) there was 10% more runoff than precipitation, which may suggest calibration error or an error in the delineated drainage area. Larger Total Suspended Solids (TSS) concentrations were monitored during all by-pass conditions resulting in poorer overall separator performance since the by-pass had a disproportionate amount of solids in the flow. The reduction in performance due to the by-pass is small (5%), however, since only 15% of the influent load by-passed the separation chamber. Lower TSS removal rates were observed during larger flow events highlighting the importance of the annual distribution of storms and site washoff characteristics. The sand/snowpile storage on the site is likely responsible for the high TSS by-pass concentrations. Given the pile storage, the TSS concentration in the runoff from this site would be a function of the rainfall intensity and would not exhibit the same washoff characteristics as a typical parking lot without exposed soil piles. The existence of exposed sand piles resulted in significant TSS loadings. The average influent TSS concentration over the nine-month monitoring period was 263 mg/l. The largest event mean concentration of influent TSS was 1236 mg/l.

During the nine-month period the Stormceptor captured approximately 37 USG (140 litres) of free oil. This is a sizeable volume considering no spill was reported during the monitoring period.

At the end of the monitoring period the Stormceptor was de-watered and the sediment load measured by two methods. The first method estimated a contour map of the sludge layer using a yardstick. Core samples were taken to determine the water content (approx. 80%) of the sludge and the dry volume of sludge was used to determine the mass in the tank. Using this method the mass of solids in the tank was calculated to be 1241 lb. (564 kg). The second method was based on measuring the weight of an empty vacuum truck, pumping the sludge to the truck, re-weighing it and subtracting the water weight based on the core sample water volume. The weight of sludge using this method was 1584 lb. (720 kg).

The estimated mass of retained sediment in the tank based on the monitoring data (45 complete events and 16 estimated events) was 1038 lb. (472 kg). Accordingly there was an underestimation of solids removed by the monitoring data (19% to 52% underestimated). A range of performance values can be calculated based on the different weights of sludge measured and assumption regarding which sampler (influent, effluent or both) was in error. The range of results for net TSS removal (including by-pass) is 26% to 37% for the nine-month period.

Results for other parameters monitored include 18% for Total Phosphorus (TP), 32% for Polycyclic Aromatic Hydrocarbons (PAH), and 18% for dissolved Phosphorus. The results for sediment associated parameters such as TP and PAH are probably underestimated as a result of the monitoring errors mentioned above.

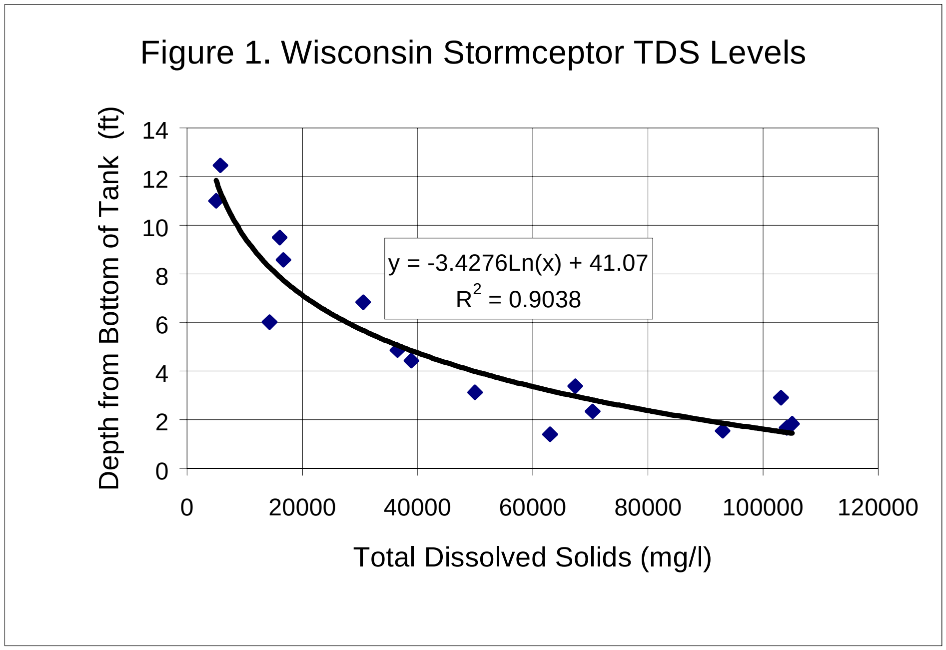
The particle size distribution influent to the tank was measured with a Coulter counter. The distribution indicated that the majority of particles influent to the tank were very fine (92% < 50 μm). The particle size in the tank itself was mainly coarse (95% > 63 μm) and contradicts the influent particle size given the performance of the unit in removing suspended solids. A potential source of error would be the location of the inlet sampler. If the sampler did not measure bedload properly it would explain the contradiction in particle size analysis and the discrepancy in TSS removal rates based on the material captured by the Stormceptor.

Extremely high Total Dissolved Solids (TDS) concentrations were measured in the tank prior to cleanout. The majority of the tank had TDS concentrations > 20,000 mg/l with the bottom of the tank having TDS concentrations in excess of 100,000 mg/l). The high concentrations of TDS are thought to be the result of the high salt loading on the site (salt storage and distribution center).

Salt storage on-site is shown on the left. While the salt storage is covered, there is considerable spillage outside of the covered area. The salt is mixed with sand on the pavement outside of the covered area and the mixed salt/sand pile is left exposed outside.

The high salt concentrations may have created hindered settling conditions and could have created a chemocline (stratified conditions). Stratification would reduce the effective volume of storage and hence retention time in the Stormceptor.

The current sizing guidelines for the Stormceptor are based on upstream drainage area and separator storage to achieve a certain performance target. Stratification would effectively reduce the storage volume making the unit a much smaller separator and less effective for the period of time that the unit was stratified. The vertical profile of total dissolved solids during pumpout is shown in Figure 1.



Although the effects of salt cannot be predicted from this study, a comparison of the TSS removals during the fall period before salting with the winter period can be made to determine whether the settling characteristics are different in the two periods.

Figures 2 and 3 provide a comparison of TSS removal for the fall period of 1996 with the winter/spring period of 1997.

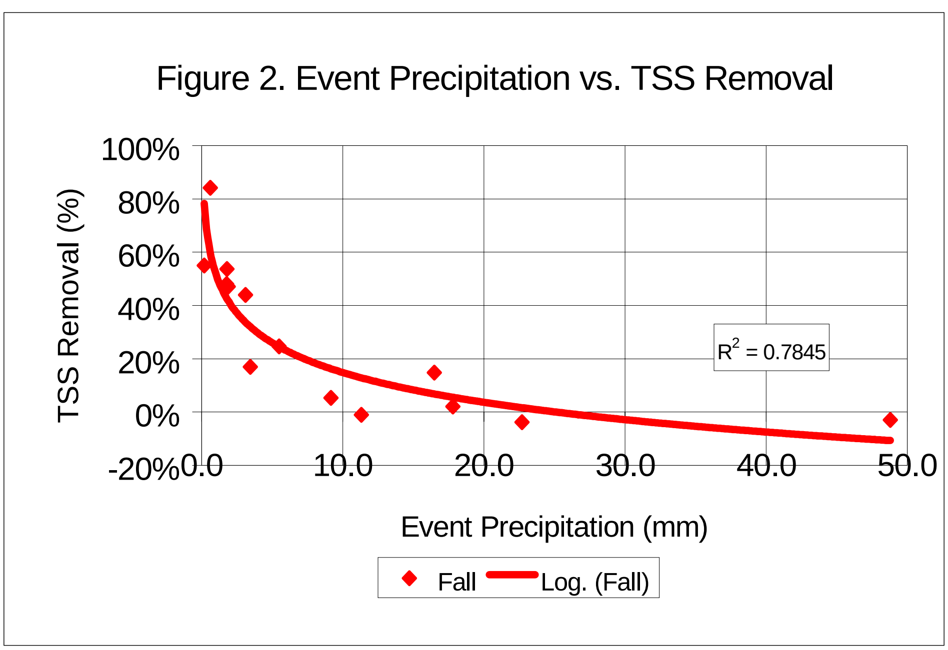


Figure 2 shows good agreement between TSS removal and storm size for the fall (no salt) period (r^2 = 0.78) while there is an extremely poor relationship between storm size and TSS removal for the winter/spring (salt) period (r^2 = 0.12).

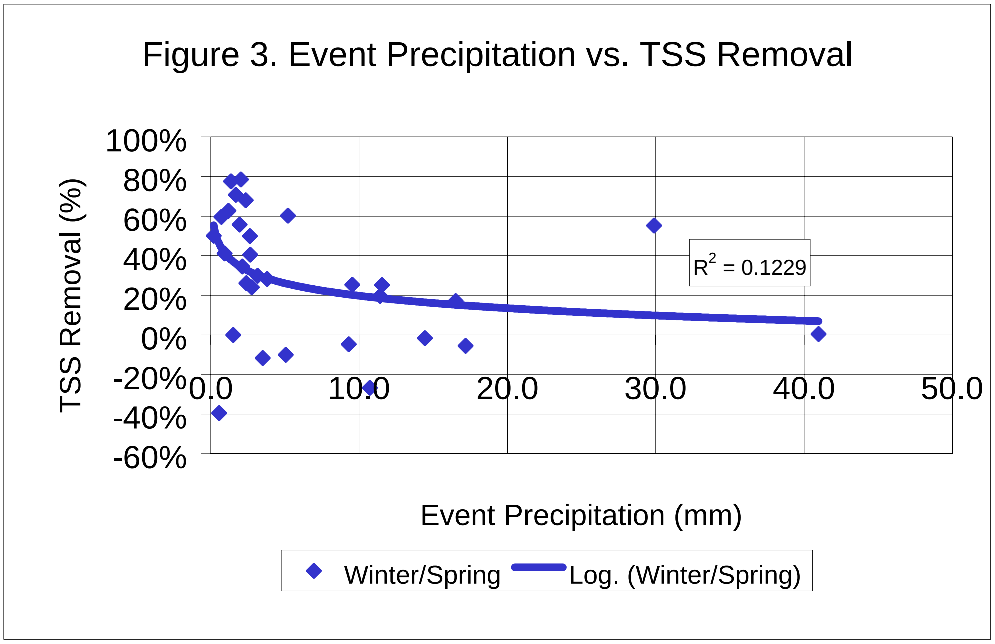


Figure 3 suggests that a high salt content in the Stormceptor may have affected the settling characteristics.

Both figures indicate that the effectiveness of the Stormceptor for TSS decreases as the storm size increases. It should be stressed that these curves are partially a function of the site conditions on the public works yard (continually high TSS loadings with storm size, i.e. no first flush ever due to storage piles, and high salt loadings). The performance would not degrade as quickly with storm size for typical urban applications such as commercial or industrial parking lots that exhibit a first flush effect, the winter/spring performance may improve without the influence of high salt loadings and summer conditions were not assessed.

Regardless of the actual relationship, TSS performance will degrade with storm size emphasizing the importance of overall hydrology (annual storm distribution) when sizing the Stormceptor for TSS removal, especially for sites where a first flush with respect to TSS concentrations does not occur.