SOME OBSERVATIONS ON ATMOSPHERIC DUST FALLOUT

by
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INTRODUCTION

For a full paper on this topic go to http://udfcd.org/techpapers.htm .

Dust fallout, as a contributor to the pollutants found on urban surfaces, has been discussed for years and many studies have been done to quantify it (Sartor and Boyd, 1972; Pitt and Amy, 1973; Pitt, 1979; Mustard *et. al.,* 1985; Schroder and Hedley, 1986; Schroder *et. al.,* 1987; NADP, 2003 (full citations are given in the paper posted on the web). Despite these, there remains controversy as to how much of the total pollutants that are present on various urban surfaces come from atmospheric fallout. This paper reports on the findings of atmospheric fallout observed in 2003 on a roof of single-family residence and in a winterized swimming pool, both located in Denver, Colorado.

ROOF GUTTERS

In May of 2003, a roof gutter not cleaned for about 5- to 7-years serving approximately 700 square feet of a single-family residence was cleaned and the materials were collected and weighted. These materials consisted of wet leaves, fine sediment and grit materials typically found on asphalt-composition roofs. The following were observed:

1) Total weight of material removed was between 30 to 40 lbs.
2) Approximately 1/3 of the mass was grit particles from the composition roof.
3) Approximately 1/3 of the mass was wet leaves and water.
4) Approximately 1/3 of the mass was very fine sediments.

From these approximations, it was concluded that the gutter accumulated about 12 lbs of very fine sediment that would be classified as part of the Total Suspended Solids (TSS) when found in stormwater runoff, or about 2 lbs of TSS per 100 square feet of roof (870 lbs/acre). This loading rate compares favorably with a value reported by other studies. What is not known is the quantity of fine solids that were not trapped in the gutter during these years and were washed down the gutter onto the lawn or onto the streets and paved alleys that hydraulically connect to the streams in the Denver area. Clearly, this example illustrates that roofs in the Denver area are significant sinks of atmospheric fallout and contributors of TSS to stormwater runoff. Similar to the findings were reported by Beecham (2001) in Sydney, Australia, namely an average load of 5 kg (11 lbs) of sediment being generated from a typical single-family residential roof on an annual basis.

A SWIMMING POOL

On Memorial Day weekend the cleanings of a residential swimming pool were sampled and analyzed. Photograph 1 in the full paper posted on the web page illustrates the difference in the pool bottom before and after cleanout. Photograph 2 in the full paper shows a Ziploc™ bag filled with fine sediment that was collected from 200 to 250 square feet of the pool's bottom. This sample does not contain all of the sediment that was on the cleaning equipment filter (approximately 15% to 25% of the sediment was not captured and went down the drain during the washing of the filter). These data indicate:

1. The total wet weight of the sample is 3 lbs.
2. The weight of the solids removed is around 1.5 lbs, or around 0.9 lbs of solids per 100 square feet of surface. Extrapolating this to a 12-month period, we get 1.2 lbs/100 s.f. (700 lbs/acre) a year.
3. This material would become part of the TSS load in stormwater runoff.

A gradation test was performed to determine the distribution of particle sizes contained within the atmospheric fallout sample taken from the swimming pool. The results of the gradation test are shown in Figures 1 and 2 of the posted paper. One-third of the sample can be classified as fine sand (> 74 microns) and two-thirds of the sample as silt and clay. Little more than 20-percent of the particles are clay sized (≤2 microns). Studies have shown an inverse relationship between particle size and pollutant concentration on street surfaces (Sartor and Boyd, 1972; Pitt and Amy, 1973; Pitt, 1979) and in bottom sediments in the South Platte River (Steele and Doerfer, 1983). Because of their small size, the clay- and silt-sized particles are the most difficult to remove from runoff by sedimentation processes.

WHAT DOES THIS MEAN?

These observations imply that atmospheric fallout is a significant contributor of TSS found in stormwater runoff in the Denver area. In a semi-arid climate wind picks up much dust and fine sediment from many surfaces within and adjacent to the urban area. Unlike climates with more rainfall and humidity, the atmosphere in a semi-arid climate does not have many opportunities to cleanse itself. In addition, native vegetated surfaces comprised of bunch grasses instead of turf grasses do not protect the soils from scour by wind, nor do they provide the trapping of dust particles that turf-forming grasses provide after particles settle to the ground.

It was also found instudies by Sartor and Boyd (1972), Pitt (1979), Mustard *et. al.* (1985) that TSS buildup rate on impervious surfaces initially occurs rapidly and then approaches an asymptotic equilibrium. This phenomenon can be attributed to wind resuspension and scour of deposited particles so that the buildup of TSS does not continue at the same rate forever. In a swimming pool, all solids that fall out of the atmosphere cannot resuspend into the atmosphere. As a result, a swimming pool, a pond or a lake acts as a perfect sink for these solids.

The findings reported in this paper are not based on accurate scientific measurements, but do provide a realistic assessment of atmospheric fallout in the Denver area and how it affects stormwater runoff quality. It is

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Phase II MS4s have a period of 5 years to fully implement their programs. The District will continue to provide assistance to its local governments as requested and with the support of the Board. The District plans to hold quarterly meetings in the future.

Phase I Municipalities

The cities of Denver, Aurora, and Lakewood are "Phase I" MS4s under the EPA discharge regulations because of their population size (greater than 100,000). The cities prepared permit applications in 1992 and WQCD issued permits originally in 1996. The cities have fully implemented all of their original permit requirements. Permits for a second 5-year permit term were renewed on March 20, 2003.
Three significant changes were made to the permit conditions. One was to shift emphasis from inspection of industrial sites to education of industries. The second change was to revise the Construction Sites Program to be applicable to proposed developments greater than 1 acre (the previous criteria was 5 acres). The third change was additional reporting requirements in the wet-weather monitoring program. In 2003, the District developed a 5-year work plan with the U.S. Geological Survey that is designed to assess long-term trends in stormwater quality for watershed planning.

Protecting Trees from Beaver Damage

By Steve Materkowski, EIT, Engineering Inspector, South Platte River Program

An integral part of re-vegetation along the South Platte River has been the planting of Plains Cottonwoods and other native tree species. Unfortunately, many of these trees have been damaged or killed by beavers. Given the time, difficulty and expense of growing trees to maturity, these losses, in the limited areas of riparian growth in an urban environment, are not tolerable.
Originally we tried to protect trees using "chicken wire" cages. These proved to be mostly ineffective. Beavers can rip down this light wire or bite through it. The more recent practice suggests using a welded wire cage. Although this system works, it is unsightly.

In 2002, we became aware of the idea of painting trees to protect them from beaver damage. This "Beaver Paint" consists of a combination of latex paint and sand. Two areas along the South Platte River with active beaver populations were chosen for initial testing. Working closely with our routine maintenance contractor, we selected the type and color of paint to use and the proportions of sand to add to the paint. We found that using approximately 20 ounces of sand per gallon of exterior latex paint worked well. We painted a total of 100 trees at the two locations. The trees ranged from 2- to 24-inches in diameter. Some of them had recent beaver damage, which meant that the paint was applied not only to outer bark but to live inner fibers as well. So far the beavers have not damaged any more trees at these two sites. Secondly, after two growing seasons all trees in the test areas appear to be in good health.

Last summer, we had our contractor paint approximately 100 trees in South Platte Park. As of this writing, there has been no further beaver damage in those areas of the park. The Denver Parks Department is also experimenting with this method .

Based on our experience so far, we recommend the following paint-sand mix for beaver protection:
1 gal. exterior grade latex paint (match paint color to color of tree bark)
20 oz. playground sand
Mix in sand thoroughly.

It is very important to remove dirt from around the base of the tree and to paint, starting at the ground line, 3 feet up the tree. Apply a thick coat to all areas being painted. We suggest you experiment with the proportions and the color to get the best results. To match the color to the tree bark, get paint swatches from a supplier or have the supplier mix the color that you need.

Each application is unique but with proper mixing, only the beavers will know the paint is there. We do expect the trees will need to be repainted every few years. The exact maintenance cycle for this has yet to be determined.

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recommended that these non-scientific initial data be better quantified through the use of more precise controlled measurements in existing sinks for atmospheric fallout (e.g., winterized swimming pools that have mesh type winter covers, lined ponds, etc.).

This less than formal data collection effort suggests that each 100 square feet of impervious surface can yield as much a 1.0 to 1.2 lbs (0.45 to 0.55 kg) of solids on an annual average basis. What fraction of this material actually makes it into stormwater has yet to be determined. If we assume 100% and an average of 30% of impervious surfaces in the metropolitan area have a direct hydraulic connection to the conveyance systems, each square mile of urban development here *can produce about 40 to 50 tons of TSS in stormwater runoff each year reaching our receiving water systes*. Considering that the Nationwide Urban Runoff Program data collected in the Denver area at commercial and residential sites by USGS indicates an average TSS concentration exceed 200 mg/L (EPA, 1983), the estimate using the unscientific samples collected this year compare well to the annual stormwater TSS loads one calculates using USGS data.

Conclusions

The observations made using simple atmospheric fallout dust capture techniques clearly show that:
1) Atmospheric fallout in the Denver area is a significant source of TSS in stormwater. 2) The fallout consists mostly of very fine particles that are hard to remove from the water column. 3) It does not matter what form the impervious surface takes, this fallout is shows up in stormwater runoff. 4) The less impervious surfaces that have a direct hydraulic connection to the conveyance system, the greater the chances for the turf lawns and landscaping to capture these fine particles before they reach the stormwater conveyance system. 5) The BMPs currently recommended in Volume 3 of the District's *Urban Storm Drainage Criteria Manual* are well suited for the removal of these fine solid particles from stormwater.