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Longevity of Infiltration Basins Assessed in Puget Sound

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Recent performance studies from the East Coast suggest that infiltration basins have a very short useful life before they clog. Failure rates of 50% and 100% have been reported. However, these studies were conducted in the mid-Atlantic region, where soils can often have marginal infiltration capacity (from 0.5 to 1.0 inch/hour) and, perhaps more importantly, have a high clay content. Other regions of the country are underlain by sandy or gravelly soils of much greater infiltration capacity. Will infiltration basins work better in these environments?

To test this hypothesis, 23 infiltration basins were surveyed in the Puget Sound Basin of the Pacific Northwest. The basins were designed for stormwater quantity control and not for water quality purposes. Detailed textural analysis and single ring infiltrometer tests were conducted on a subset of eight basins. In addition, stormwater managers and public works officials were interviewed to obtain a general assessment of how infiltration basins performed over time.

A number of factors would seem to promote better longevity in the Puget Sound area. First, basin soils had exceptionally high infiltration rates, ranging from 1.1 to 36 inches/hour (coarse gravelly sandy loams and fine sandy loams). Second, clay content of the underlying soils was never greater than 13% in any basin tested. Lastly, inspections and corrective maintenance had been regularly conducted at many of the basins, at least in the last few years.

On the other hand, most of the basins were constructed prior to the most recent infiltration basin design guidelines, issued by the Washington Department of Ecology (see Table 1). Consequently, few of the basins had effective pretreatment features, such as biofilters, forebays, or filter berms, that are now required on new infiltration basins.

The results of the survey indicate that while a majority of the infiltration basins were still working properly after 10 years, many had encountered problems (see Table 2). For example, 26% of basins surveyed had standing water in between storms, as well as wetland vegetation. In each case, the failure was attributed to a locally high water table. Noticeable sediment deposition was observed at 35% of all basins. A review of maintenance records indicated that scarification (sediment scraping) had been conducted at 43% of the sites in the last five years.

The average cost to maintain the basin ranged from $500 to $1,000 per year. A frequent maintenance headache was the difficulty in sustaining grass on the basin floor—only 30% of all basins had a dense grass cover crop. The thin grass cover was due to frequent inundation, poor soils, or standing water. Lack of grass cover and the presence of trash and debris often generate complaints from adjacent residents.

The study also compared measured infiltration rates at the basins with the predicted rate, based on the local soil survey or SCS textural estimation method (Table 3). The three methods gave inconsistent and variable estimates of the design infiltration rate. The single ring infiltrometer test tended to give the highest estimates of the infiltration rate, and is often used as an maximum or upper limit in the Puget Sound area. Clearly, for the soils in the Puget Sound Area, and perhaps elsewhere, the various soil infiltration methods provide only a guidepost for the true, but unknown, infiltration rate. Given the critical importance of the infiltration rate in selecting and designing infiltration practices, more research is needed to develop more effective and reliable methods to rapidly calculate it.

A companion study (Gaus, 1993) examined the concentration of trace metals in the surface soils of eight infiltration basins studied by Hilding. The average soil concentrations were 387 mg/kg for zinc, 261 mg/kg for

Table 1: Current Washington Dept. of Ecology Guidelines for Infiltration Basin Design (1992)

- Minimum infiltration capacity (fc) of 0.5 inch/hr.
- Maximum clay content of 30%.
- Maximum silt-clay content of 40%.
- Depth to bedrock and high water table of three feet .
- Maximum ponding time of 24 hours.
- Pretreatment required (forebay, biofilter, or sedimentation chamber).
- Measured Infiltration rate reduced by factor of two for design.
- Basins control 6 month, 2 year and 10 year, 24 hr rainfall events. If Fc is greater than 2 in/hr, water quality storm must be treated to protect groundwater.

Table 2: Summary of Field Survey of Puget Sound Infiltration Basins

Field Parameter	Value
No. of basins surveyed	23
Mean age of basins	10.6 years
Mean infiltration rate (in/hr)	15.8 (range 1.1 to 36.0)
Maximum clay content	never exceeded 13% at any site
Had runoff pretreatment	39%
Had standing water	26%
Heavy sediment deposition	35%
Scarified in last 5 yrs. to improve infiltration rate	43%
Had dense grass cover	30%
Needed mowing or seeding	31% to 44%
Annual maintenance cost	$500 to $1000 per basin

Table 3: Method Used to Estimate Soil Infiltration Rates (in/hr)

Basin #	Soil survey permeability rates (in/hr)	SCS soil texture method	Field measurement single ring infiltrometer
Basin # 1	6-20	1.02-8	26.4
Basin # 2	6-20	20	7.2
Basin # 3	6-20	20	14.4
Basin # 4	6-20	2.4	36
Basin # 5	6-20	2.4	36
Basin # 6	0.6 to 2.0	2.4	19.2
Basin # 7	6-20	2.4	1.1
Basin # 8	6-20	2.4	2.2

lead, and 153 mg/kg for copper. Downward metal migration was not observed at most sites. A notable exception were basins situated on coarse gravelly soils. In these cases, some form of pretreatment prior to infiltration would be advisable to prevent groundwater contamination.

The field surveys do suggest that infiltration basins can still be an attractive stormwater option in regions with a high infiltration rate and stringent design guidelines. Even under these ideal conditions, however, extensive maintenance is required to keep the practice working over the long term.

References

Hilding, K. 1993. *A Study of Infiltration Basins in the Puget Sound Region*. ME thesis. Dept. of Biological and Agricultural Engineering. Univ. of California, Davis.

Gaus, J. 1993. *Soils of Infiltration Basins in the Puget Sound Region: Trace Metals and Concentrations.* ME thesis. Univ. of Washington.