Bureau of Environmental Services • City of Portland

2006 Stormwater Management Facility Monitoring Report SUMMARY

Sustainable Stormwater Management Program

September 2006

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Sam Adams, Commissioner • Dean Marriott, Director

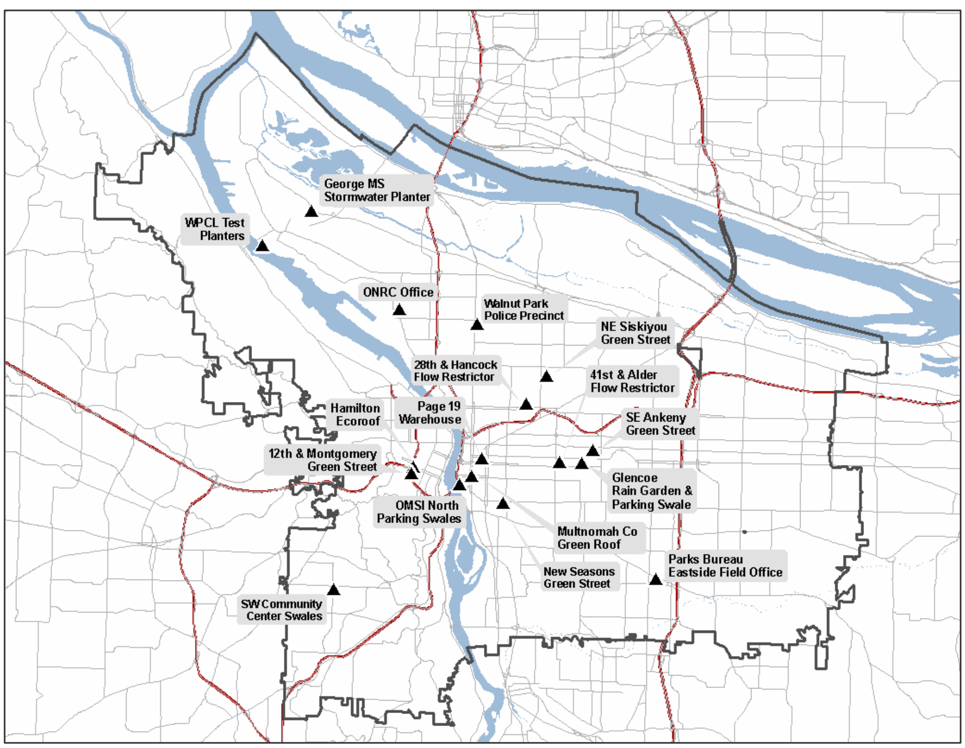
Introduction

The Sustainable Stormwater Management Program (SSMP) is a multi-discipline team that works within the Bureau of Environmental Services and with other city Bureaus to address stormwater quality and quantity issues at the policy, planning, design, and implementation levels. One particular focus has been the performance evaluation of stormwater management facilities.

Stormwater management facilities handle runoff from impervious areas and alleviate potentially negative impacts to the combined and storm sewer systems, and to watershed health. In particular, they can be used to reduce peak flows, reduce runoff volume, and improve water quality. Vegetated facilities are ideal because they reduce impervious area, improve aesthetics, provide a natural biological system that maintains infiltration pathways, and filters out many typical stormwater pollutants.

Information on how well facilities perform is critical to quantify their benefits, lower maintenance costs, ensure public safety, and improve overall design and function. In particular, information was desired on how well the facilities could reduce peak flows and total flow volume, which have implications for watershed health and regulatory compliance in the combined sewer system. Water quality monitoring is limited but will be increased in the future as budget allows. Sampling of facility soils was also begun to determine if there are any long-term issues with pollutant accumulation.

Monitoring data collected through December 2005 is included in this report. Evaluated facilities are located throughout the city and represent an effort to include a variety of facility types, configurations, ages, and land uses. General facility types included here are: Ecoroofs, Green Streets, Vegetated Infiltration Basins, Stormwater Planters, and Flow Restrictors.



Facilities Evaluated in 2005

Ecoroofs

Multnomah County Green Roof

Hamilton Apartment Ecoroof

Ecoroofs, also called Green Roofs, consist of soil media and plants installed above traditional roofing materials. The soil media retains rainfall, which can then be sent back into the atmosphere through evapotranspiration.

Results from two ecoroofs are included: the Hamilton Apartments Ecoroof and the Multnomah County Building Green Roof. The Hamilton Ecoroof has two different roof types – a thinner, lighter soil media (east side) and a thicker, heavier soil media (west side).

All roof configurations do an excellent job of reducing peak flows and would help decrease basement sewer backup risk. Volume retention varied widely across the roof configurations. As expected, retention is higher in the summer (low rainfall, high evapotranspiration rates) and lower during the winter months (high rainfall, low evapotranspiration rates). Higher retention in the summer is important because regulations for water quality and combined sewer overflows are most stringent between May and October.

Ecoroof Performance Summary

Facility	Monitoring Period	Size (sq ft)	Peak Flow Reduction	Volume Retention			
				Annual	Summer	Winter	CSO[1]
Hamilton Apts, West Side (Hamilton West)	4 years Jan 2002 – Dec 2005	3,655	97%	56%	86%	47%	61%
Hamilton Apts, East Side (Hamilton East)		3,811	95%	27%	67%	14%	N/A[2]
Multnomah County Green Roof	1½ years Jul 2004 – Dec 2005	7,000	86%	3%	-18%[3]	19%	11%

[1] For storms most similar to the Combined Sewer Overflow (CSO) Design Storms.
[2] Event data from the east side of Hamilton showed an exceptional amount of scatter. Some events were retained well (up to 66%) while others showed negative retention (down to –10%). This is likely the result of drainage issues that result in unintended runon from the conventional penthouse roof.
[3] Negative value is the result of daily irrigation runoff from July through September.

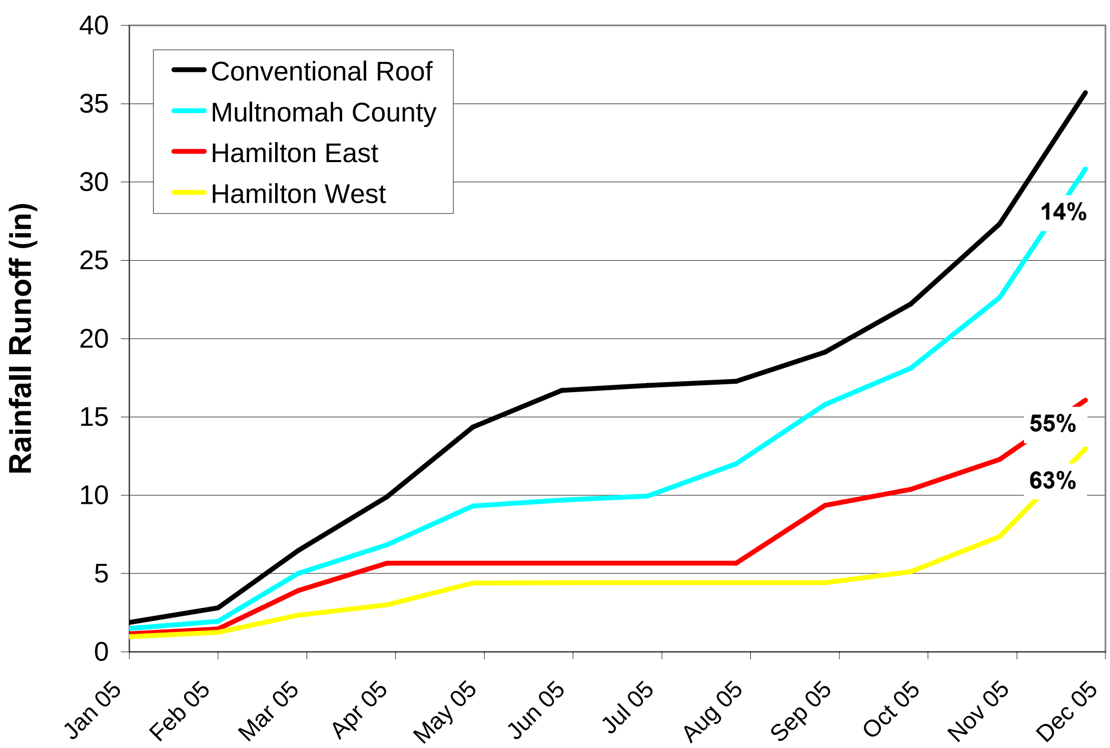
Hamilton West has the highest retention rates – both annually and for each season. While there are many potential variables that will impact volume retention (like the drainage design, exposure to sun and wind, amount and timing of irrigation, etc.), it appears the major difference between the ecoroofs is the soil media used. Unlike the other two configurations, the soil used on Hamilton West contains a substantial amount of fine particles (sandy loam). A soil mix with fine particles should be better at holding water against gravity – allowing more time for evapotranspiration to occur and for ingredients like digested paper fiber and organics to absorb water. It is also possible that the finer soil particles partially clog the filter fabric that separates the soil from the drainage layer. This would produce the same effect – water would be held against gravity and kept out of the drainage system.

Ecoroof Soil Media Comparison

Facility	Soil Thickness (in)	Soil Type
Hamilton Apts, West Side	5	sandy loam, perlite, digested paper fiber, coconut coir, compost
Hamilton Apts, East Side	3	encapsulated Styrofoam, perlite, digested paper fiber, coconut coir, compost, peat moss
Multnomah County Green Roof	6	perlite, pumice, paper pulp, digested paper fiber

Hamilton East has 3 inches of soil media – the thinnest of the three configurations. The soil media is more porous than Hamilton West's but not as porous as Multnomah County's. Drainage problems on the east side of the conventional penthouse roof can result in additional runoff onto the east ecoroof. This makes conclusions difficult. Retention has been lower on Hamilton East than Hamilton West, but that would be expected given a more porous soil media and a shallower soil depth. East retention compared to West is noticeably less in the winter, but is only marginally lower in the summer.

The Multnomah County Green Roof uses a lightweight and highly porous soil media. This type of soil media is often used to ensure that saturated soil weight does not exceed the structural capacity of the roof. However, it is possible for the media to be too porous and allow water to drain through too rapidly. Though the Multnomah County Green Roof is the thickest at 6 inches, it retains the least volume. This is partly due to the substantial irrigation applied to keep the roof green during the summer. The irrigation combined with a porous soil media leads to substantial daily irrigation runoff which greatly reduces overall retention.



Ecoroof Runoff Retention for 2005

It is interesting to note that annual and seasonal retention for both Hamilton West and Hamilton East improved over each of the four years of monitoring. This would suggest that retention performance can improve as the soil and plant complex matures. It will be interesting to see if the younger Multnomah County Green Roof shows a similar trend as it ages.

Annual runoff retention by year for the Hamilton Ecoroof

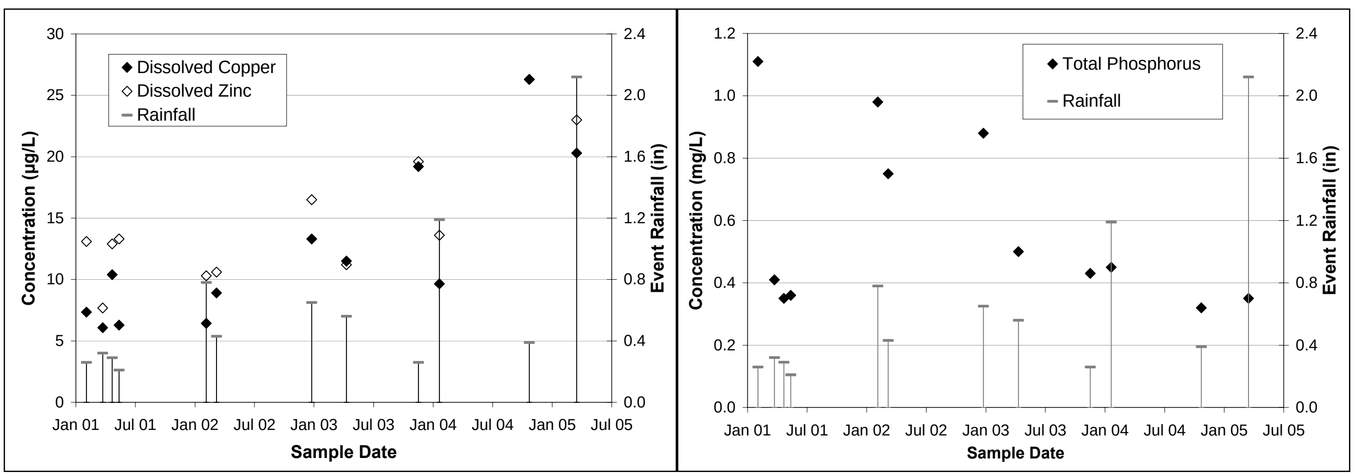
Year	2002	2003	2004	2005
Rainfall (in)	21.6[1]	37.1	26.0	36.1
West Retention	**41%**	**54%**	**62%**	**63%**
East Retention	**4%**	**9%**	**32%**	**55%**

[1] Runoff meter was down for the first half of December 2002, so it was not included in the totals (29.8 inches otherwise).

The potential export of metals and nutrients in ecoroof runoff was also of interest because of regulatory requirements and watershed health objectives. Runoff samples from both sides of the Hamilton Ecoroof have been collected for twelve storm events over the last four years.

Zinc and copper levels in the runoff appear to be rising over the past four years. Though concentrations of both were well below human health guidelines, many samples contained levels of copper that may adversely impact aquatic life (> 7 µg/L). The soil media, especially from Hamilton West, contains zinc and copper, but the corrosion of roofing materials – flashing, railings, etc. – and metals in rainfall may also contribute.

Phosphorus concentrations appear to be decreasing over time but are still high (0.35 mg/L) when compared to benchmarks established in some Portland watersheds (0.13-0.16 mg/L).



Trends for copper, zinc, and phosphorus from Hamilton West runoff samples

This data represents a small sample of events collected only during winter and spring months. More sampling is necessary to determine: 1) if concentrations are truly significant, 2) how levels compare to concentrations found in rainfall and conventional roof runoff, and 3) the source – soil media, roofing materials, rainfall, etc. Despite the remaining questions, current data does indicate that selection of an appropriate soil medium should include an evaluation of potential water quality impacts.

Ecoroofs – Monitoring Observations

- All configurations were effective at reducing peak flows.
- Volume retention is highly dependent on the soil media. Lighter, more porous media appear to have a limited ability to retain volume while heavier, denser soil media provided the best volume retention.
- Summer irrigation should be minimized to maximize storage capacity in the soil media and to prevent irrigation runoff.
- Metal (copper, zinc) and nutrient (phosphorus) concentrations in ecoroof runoff were at levels that could impact watershed health. More information is needed to determine how these concentrations compare to runoff from traditional roofs.

Green Streets

Green Streets are vegetated facilities, typically within the public right-of-way, that manage street runoff. Facilities can be in a variety of configurations – including swales, curb extensions, planters, and infiltration basins. Design variables are flexible, but facilities are typically linear and 6 to 9 inches deep.

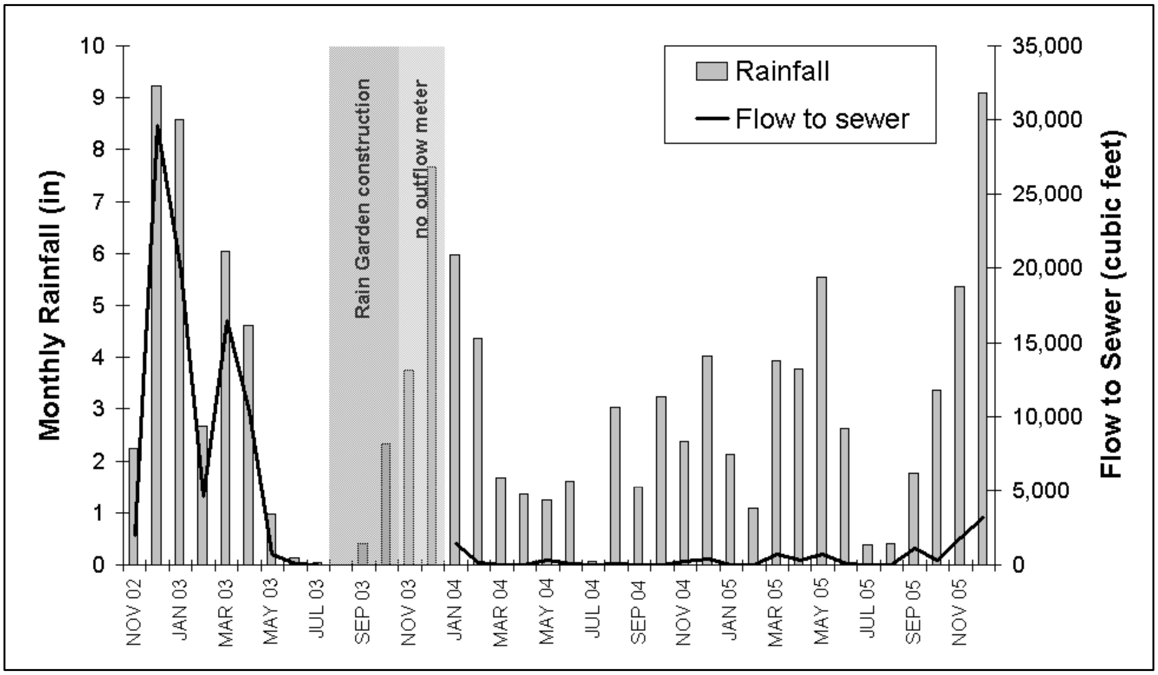
The two oldest Green Street facilities – the Glencoe Rain Garden and the Siskiyou Green Street – have been monitored over the past two years. An evaluation of both flow tests and actual storm events indicate a strong ability to limit peak flows. The lowest peak flow reduction for the most intense design storm (the 25-yr, 6-hr storm) was 80%. This would be enough to eliminate basement sewer backup risk in almost all circumstances.

The Green Street facilities also provide a notable reduction in the flow volume entering the combined sewer. Annual runoff has been reduced by up to 94%, and flow tests simulating CSO design storms have resulted in retentions as high as 80%.

Performance summary for Green Street projects

Facility	Location	Monitoring Period	Drainage Area (ft^2)	25-Yr Peak Flow Reduction	Annual Runoff Retention	CSO Flow Volume Retention
Glencoe Rain Garden	SE	2 years Jan 2004 – Dec 2005	34,800	80%	94%	80% +
Siskiyou & 35th	NE	2 years Jan 2004 – Dec 2005	9,300	85%	>80%	61% +

Results have been generally consistent regardless of antecedent rainfall, and overflow to the combined sewer only occurs during the larger storms events.



Inflow volumes to the combined sewer
before and after construction of the Glencoe Rain Garden (94% reduction)

Infiltration tests have been conducted on four Green Street facilities. It was assumed that the high variability in urban soils would lead to highly variable infiltration results. However, all facilities have been remarkably consistent despite differences in facility age, drainage area, geographic location, and antecedent moisture conditions. Though average infiltration rates have been variable, the minimum (or steady state) rate approached over time has been consistently between 1½ and 2½ inches per hour.

Glencoe Rain Garden

Infiltration Test Summary for Green Street Projects

Facility	Location	Facility Area (ft^2)	Test	Minimum Infiltration Rate (in/hr)
12th & Montgomery	SW	270	SEP 05	2.5
Ankeny & 56th	SE	460	NOV 04	1.8
Glencoe Rain Garden	SE	1,975	AUG 04	1.8
			MAY 05	3.0
Siskiyou & 35th	NE	590	AUG 04	2.0
			APR 05	1.5
			NOV 05	2.5

The consistency of results may indicate a greater than expected uniformity in urban near-surface soils, or it could reflect a focus on soil preparation during construction designed to promote infiltration. Most facilities use a specified mixture of topsoil, sand, and compost (a "three-way" mix) for the first 12 to 18 inches of soil depth. The boundary between imported and native soils is tilled to prevent a "hard" interface, and the imported soil is installed in lifts with no mechanical compaction.

For facilities, like the Glencoe Rain Garden, which use only the native soil with no amendments, a tiller or "ditch-witch" is used to loosen the soil. Tests will continue over time to determine changes in infiltration rates as the facilities age.

Several design issues have been identified that should be considered for future projects.

- facility overflow heights should be adjustable to maximize storage volume as infiltration performance changes over time
- facilities on flat streets (<1% slope) require obstruction free entries to ensure water moves into the facility and does not bypass around
- entries should not be angled 90 degrees from the direction of flow without substantial measures (e.g. small berms at the downstream end of the entry or substantially depressing the gutter in front of the entrance) are taken to encourage curb flow to enter the facility.

NE Siskiyou Green Street

Sediment accumulation has been significant in all facilities, and it is important to provide a forebay or other accommodation for sediment removal. Accumulation varies depending upon site characteristics, but a removal frequency of at least twice a year seems appropriate. As with any vegetated facility, there may be some need for irrigation – especially during the first two years when plants are establishing. After that, the plants are expected to survive on rainfall alone. Weeding is also important during the establishment period and needs to be done three to four times a year. As the plants mature, only minimal weeding should be necessary and that could be done in conjunction with sediment removal visits.

SW 12th Green Street

This initial set of data indicates that the monitored Green Street facilities have tremendous potential to manage stormwater rate and volume. The City of Portland is actively pursuing a citywide program of green street implementation, launching the Cross-Bureau Green Street Program in 2005 to provide a streamlined process for implementation in the future.

SE Ankeny Green Street

Green Streets – Monitoring Observations

- All facilities are effective at reducing peak flows
- The potential for volume retention during CSO compliance events appears to be high. Retention was at least 60%
- The facility overflow should be at the highest elevation possible to maximize the storage volume of the facility – especially for steep streets (>2%)
- Facilities on gently sloping (<1%) streets require designs that allow easy entry into the facility. The presence of check dams or substantial vegetation too close to the curb entry may create resistance to flow that encourages bypassing around the facility
- Facility entries angled at 90 degrees to the flow direction, require substantial design elements (berms, depressed gutters, etc) to prevent significant bypass during large events
- Infiltration rates have been consistently 1½ inches per hour or higher.
- Weeding and sediment removal are the primary maintenance activities, with frequency determined by the characteristics of each street. However, sediment removal and weeding should occur at least twice a year.

Vegetated Infiltration Basins

Vegetated infiltration basins are landscaped depressions designed to hold and infiltrate water. They are very similar to the Green Street facilities, but they have generally greater depths (at least 9 inches), a larger footprint, and also accept runoff from roofs and parking lots.

Four were tested for infiltration rates, and all performed well. OMSI, ONRC, and the Parks Eastside Field Office have high rates, but they also overtop gravelly soils that would be assumed to infiltrate well. Page 19 has a lower rate, but is located over urban fill that typically contains a fair amount of silt. The rate at Page 19 is very similar to the rates found for the monitored Green Street facilities which also typically overly silty urban fills.

Infiltration Test Summary for Vegetated Infiltration Basins

Facility	Location	Facility Age (years)	Test Date	Antecedent Conditions	Minimum Infiltration Rate (in/hr)
OMSI North Parking Lot	SE	13	JAN 2005	dry	**6.0**
ONRC Parking Lot	N	3	FEB 2005	dry	**4.5**
Page 19 Parking Lot	SE	3	MAR 2005	very wet	**1.5**
Parks Eastside Field Office	SE	3	JUL 2005	dry	**4.2**

The majority of facilities tested to date are young – no more than three years old. However, the OMSI swales were constructed in 1992 and are still performing very well. A test was performed at the OMSI swales in 1995, and though a minimum infiltration rate was not mentioned for this test, the average rate was reported to be 8 inches per hour. The average rate for the test in 2005 was 13 inches per hour – indicating that infiltration capacity has actually increased over time. This reinforces the idea that mature vegetation with woody root structures can open and maintain pathways within the soil and consequently improve infiltration.

OMSI North Parking Lot Swales

Each vegetated infiltration basin will typically have a unique combination of subsurface soils, drainage area characteristics, and facility design variables that make results difficult to extrapolate to other locations. However, by accumulating infiltration data from a number of facilities, it is hoped that trends can be identified. Those trends may then allow the assumptions currently used in estimating the effectiveness of infiltration facilities to be refined.

ONRC Infiltration Basin

Additional tests are planned for the future to track changes in infiltration over time, and to attempt to link infiltration performance to design variables and the type and frequency of maintenance activities. Future testing may also involve peak flow and CSO design storms.

Vegetation Infiltration Basins – Monitoring Observations

- Infiltration rates have met or exceeded expectations at all facilities.
- Vegetated infiltration facilities can improve over time. Roots from vegetation – especially woody plants – have extensive root structures that counter siltation and can loosen soils compacted during construction.
- Minimum infiltration rates for the vegetated infiltration basins (and Green Street facilities) have been consistently greater than 1½ inches per hour. This exceeds the assumption currently used to evaluate potential benefits of infiltration facilities (currently 1 inch per hour).

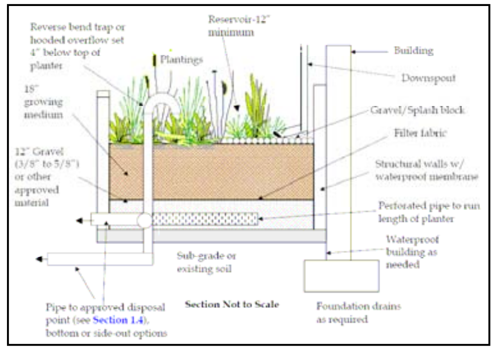
Page 19 Infiltration Basin

Parks Field Office Infiltration Basin

Stormwater Planters

Stormwater planters are vegetated facilities with vertical, structural walls. ***Infiltration*** planters have no bottom and allow runoff to infiltrate into the surrounding soil, while ***flow-through*** planters have a bottom and an underdrain system that directs flow to a sewer pipe or surface drainage. Both types can be designed in a variety of configurations to fit within existing site constraints.

Infiltration planters provide peak flow reduction, flow volume reduction, and water quality treatment, but the native soil must infiltrate well and they must be a safe distance from anything that might be damaged by soil moisture. Soils and distances can be a problem in ultra-urban areas.



Flow-through Planter

Flow-through planters are especially versatile because they can be used in areas with poorly draining soils or adjacent to structure foundations. They also provide peak flow reduction and water quality treatment, but because some flow volume passes through the underdrain system they provide only partial volume retention.

Because of their versatility, flow-through planters are likely to be heavily used in the future. However, it has been unclear how well flow-through planters will retain volume, and this is important information to determine long-term compliance with CSO regulations. Monitoring began in 2005 on two flow-through planter systems to compare inflow and outflow volumes. One is a retrofit of an existing landscape planter at George Middle School and the other is a series of test planters at the BES Water Pollution Control Lab (WPCL).

George Middle School Planter and monitoring equipment

The George Middle School planter was constructed in 2004 to handle runoff from a small portion of roof at the school. Problems with the facility became evident when winter runoff ponded on the surface with little or no flow reaching the underdrain. It is suspected that an improper soil was used during construction and it may have clogged the filter fabric separating the soil and underdrain system. The soil was replaced with a different mix, but in an effort to improve drainage, a porous soil was used. This led to exact opposite problem – the soil drains so well that runoff passes quickly through the soil and into the underdrain, resulting in minimal retention. Additional modifications are planned for early 2006 that will hopefully correct the problem and allow meaningful flow data to be collected.

WPCL Test Planters

The WPCL test planters were constructed to compare various planter design elements side-by-side. Four planters were constructed, each with 120 square feet of surface area (sized to manage up to 2,000 square feet of impervious area). Each bay is configured differently to compare: 1) geometry (long and narrow versus short and wide); 2) soil mixture (sandy loam with varying amounts of amendments); and 3) ways to protect the underdrain system from sedimentation (filter fabric or a gravel blanket).

Performance data is limited, but all the WPCL planters are able to reduce peak flow by at least 91%. Planters tested for volume retention also showed considerable promise, retaining between 29% and 47% of inflow volume. The planter with the most amendments (primarily digested paper fiber and coconut coir) retained the most. There has been no significant difference between the filter fabric and gravel blanket, but it is expected that any differences between methods of protecting the underdrain will take some time to develop.

Estimated volume retention for one test of the WPCL Planters

BAY	Test Inflow (gallons)	Potential Outflow* (gallons)	Potential 24-hr Volume Retention
1 (soil 1, filter fabric)	875	600	31%
2 (soil 2, filter fabric)		465	47%
3 (soil 1, gravel blanket)		625	29%

* Estimated based on recession data from the first two hours of outflow.

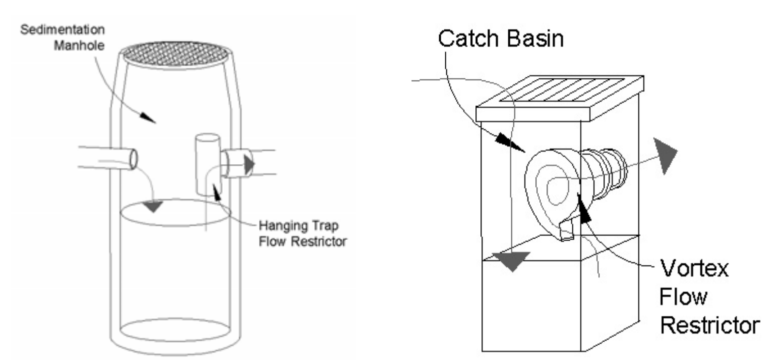
At this point, it appears that flow-through stormwater planters are effective at managing volume. The type of soil used appears to be very important in determining the ability to retain volume. More data collected from the WPCL and George Middle School planters, in addition to data from a new facility at the ReBuilding Center, will further clarify results in 2006.

Flow-through Stormwater Planters – Monitoring Observations

- Planters provide excellent peak flow reduction
- Preliminary results indicate the ability to retain between 25% and 50% of CSO design storm volume.
- Soil selection appears to be an important variable. The soil with the most amendments (like digested paper fiber) provided the most volume retention benefits during limited testing in 2005. An ideal soil mix must be able to promote healthy vegetation, provide adequate water quality treatment, and retain water volume.

Flow Restrictors

Flow restrictors are devices installed in inlets or manholes to limit the peak flow entering the sewer system. Excess flow is temporarily ponded on the street surface, expected to occur once every 3 to 4 years, with a ponding depth of no more than four inches and a ponding duration of less than one hour. They are most practical on residential streets with low traffic speeds. When space is not available for vegetated facilities, they can be useful in addressing basement sewer backup risk. However, they provide no significant benefit to flow volume reduction or water quality control.



Typical flow restrictor configurations

There are two basic unit types – the hanging trap and the vortex restrictor. The hanging trap uses a small diameter orifice (typically 3 to 4 inches in diameter) to limit flow into the outflow pipe. The outlet is elevated off the bottom of a sedimentation manhole or catch basin to allow room for debris to accumulate without clogging the opening. Hanging traps can be built from commonly available PVC pipe.

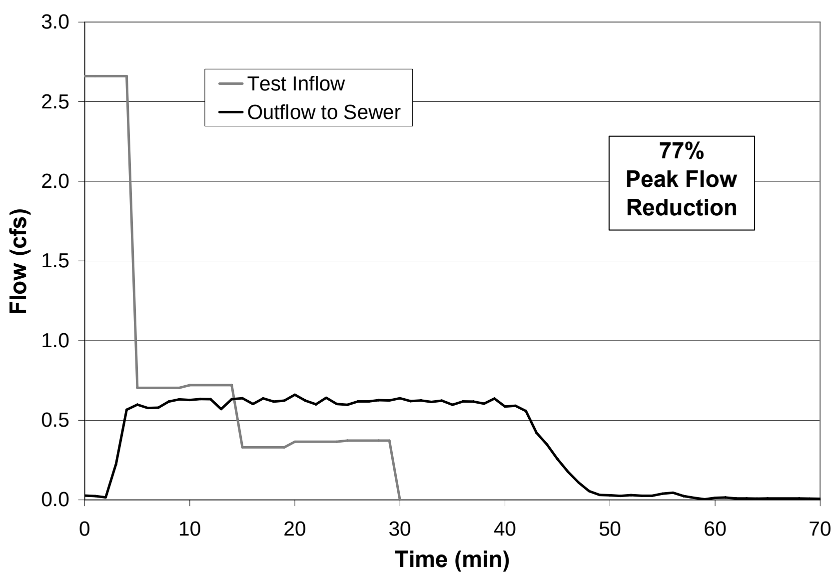
Hanging Trap ***(left, upside down showing orifice)***
and Vortex Unit ***(right)***

The vortex restrictor limits flow by forcing flow through a chamber that creates turbulence. Turbulence limits flow rates much more than a simple orifice, while maintaining a relatively large flow opening that can reduce the chance of clogging. The vortex units are also elevated off the bottom to allow room for debris accumulation. Vortex units must typically be obtained from vendors and can be expensive.

The hanging trap can be used to limit flows to around 0.5 cfs which makes them useful for drainage areas in excess of 8,000 square feet. Vortex restrictors can limit flows to around 0.15 cfs so can be used on drainage areas as small as 2,500 square feet. The units can be placed in individual catch basins to control a single inlet, or they can be placed as a centralized control in a sedimentation manhole that can handle multiple inlets.

Clogging is the primary maintenance concern. Both restrictor types have flow openings much smaller than standard inlet pipes so combinations of sticks, leafs, and trash can block the device and cause frequent ponding. Sediment must also be removed to ensure that the devices do not become buried, but this maintenance is identical to that currently performed for existing sedimentation manholes and catch basins.

A flow test simulating the 25-yr Design Storm was performed at a test installation at the intersection of SE 41st & Alder. The restrictor at this location is a hanging trap, and it acts as a centralized control for three inlets. During the test, the unit lowered the peak flow to the combined sewer by 77% – an excellent result that would provide basement sewer backup protection in most circumstances.



Peak flow reduction for the 41st & Alder hanging trap

Several vortex restrictor installations are being evaluated for general function and maintenance needs, but no testing has been done to date. One vortex restrictor did clog when a straw and stick wedged into the opening and formed a framework for leaves and other debris to block flow. Locating and removing the obstruction was time consuming, and suggests that ongoing maintenance could be extensive. However, it is encouraging that none of the other installations have had problems. As more time passes at these test installations, their long-term maintenance requirements should become clear.

Street ponding during test at SE 41st & Alder

Vortex restrictor installed in a catch basin

Hanging trap installed in a sedimentation manhole

Flow Restrictors – Monitoring Observations

- The units reduce peak flow as expected.
- Hanging traps can be cheaply made using common pipe materials, but are only suitable for drainage areas of 8,000 square feet or more.
- Vortex units must be obtained from a vendor, so cost and availability can be problematic. However, they are well suited for drainage areas as small as 2,500 square feet.
- Centralized controls installed in sedimentation manholes simplify maintenance. Sedimentation manhole maintenance is a routine procedure, and centralization provides a single maintenance point as opposed to two to four individual inlets.
- Ponding must be shallow and infrequent to maintain public safety and acceptance. Public receptivity is a primary issue.

Soil Sampling

BES wants to ensure that surface stormwater management facilities do not create localized areas of high pollutant concentrations. A program of periodic soil sampling of selected facilities will be used to track changes in pollutant levels over time to determine if pollutant levels are changing over time. Facilities were selected to provide a good sampling of facility types, age, and land uses.

Samples were taken at three different horizons at several locations within each facility. Horizons were 6 inches thick representing the surface (0 to 6 inches), root zone (6 to 12 inches), and native soil (12 to 18 inches). Samples are tested for heavy oils, metals, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

The first set of samples taken in late 2005 represent the baseline against which future samples will be compared to determine if concentrations are increasing, decreasing, or staying constant. Samples will be taken every 2 years and analyzed for trends. While a single data point can provide only limited information, the initial results do point out some trends that will be monitored as sampling continues.

Facilities Selected for Soil Sampling

Facility	Location	Drainage	Age (yrs)	Land Use
12th & Montgomery Green Street	SW	Street	1	COM
Glencoe Parking Swale	SE	Parking	3	RES
Glencoe Rain Garden	SE	Street	2	RES
New Seasons Green Street	SE	Street	1	COM
OMSI, North Parking Lot	SE	Parking	13	IND
Siskiyou Green Street	NE	Street	2	RES
SW Community Center Parking Lot	SW	Parking	9	RES
Walnut Park Precinct Parking Lot	NE	Parking, car washing	9	COM

There appears to be no threat to human health from metals or VOCs in any of the tested facilities. However, at least one sample from each facility contained levels of zinc that may negatively impact plants and invertebrates. This conflicts with visual observations of these facilities, where the plants appear healthy and earthworms are frequently observed. Current levels are generally near the benchmark, so it may be that levels are not yet high enough to have a significant impact. It is not unusual for local soils to be high in zinc because of their volcanic nature, so it may be that facility levels are not substantially higher. It may also be that some of the sample points with the highest readings represent locally high concentrations that are not present throughout the facility.

Several facilities have levels of the PAH benzo(a)pyrene that exceed at least one screening level for human health exposure – the Environmental Protection Agency Region 9 Preliminary Remediation Goal (PRG) for Superfund residential soil cleanup. This is by far the strictest health guideline for benzo(a)pyrene in the nation, and is applicable for Superfund sites to used for residential development. Stormwater facilities taking street and parking runoff are not currently required to meet residential requirements, but benzo(a)pyrene levels will be closely watched in future sampling to determine how levels are changing over time. Of the facilities that exceed the screening level, there appears to be no strong correlation with land use or age.

Soil Sampling – Monitoring Observations

- This is only the first of a series of samples that will be necessary to identify any trends that may exist. Additional samples will be taken every 2 to 3 years.
- All facilities had levels of zinc near the threshold that could negatively impact plant and invertebrate life, but there are no obvious problems within the facilities.
- Benzo(a)pyrene was found in several facilities at levels above California human health guidelines for cleanup of soils for residential use. Future testing analysis will focus on this PAH to determine if levels are increasing over time.

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