Glencoe Elementary School
Parking Lot Retrofit

825 SE 51st Street

Project Summary

Project Type:	Institutional parking lot retrofit – demonstration project
Technologies:	Vegetated infiltration swale with check dams
Major Benefits:	• The impervious area of the parking lot was reduced by almost 30% and just 3 parking spaces were lost (out of 38 original spaces). • The swale helps reduce local surcharging of the combined sewer, helps reduce Combined Sewer Overflows (CSO's), and improves runoff water quality.
Cost:	$93,858 ($6.26/sq. ft. of impervious area managed). The City (BES and Portland Parks and Recreation Bureau) designed and built the project. The project was funded by BES' Willamette Stormwater Control Program[1].
Constructed:	July – September 2002

Aerial view of the Glencoe parking lot before retrofit; 2002

Aerial view of the same parking lot after the retrofit; 2003

[1] Portland's Bureau of Environmental Services (BES) implemented the Willamette Stormwater Control Program in 2001. The Program offered financial grants and technical support for a series of projects to retrofit existing commercial properties with stormwater controls incorporating green technologies. The Program recruited these demonstration projects in order to research the feasibility, cost and performance of commercial stormwater retrofits in the area served by the combined sewer. The Program provided grant funds for a total of eleven projects. The projects were completed July 1, 2003.

Overview of the Stormwater System

- Approximately 4,400 sq. ft. of impervious surface was converted to landscape areas (including the infiltration swale).
- Two speed bumps intercept sheet flow from the parking lot and direct it to the swale. Raised parking stripes also help direct flows into the swale.
- Most of the runoff enters the swale at three entry points (top, middle, and bottom).
- Log check dams help retain stormwater passing through the swale. In larger storm events when the system reaches capacity, excess flows drain through a standpipe in the bottom compartment of the swale.

Overview of parking lot; April 2004

Close - up of the swale; May 2004

System Components and Stormwater Capacity

I. Introduction

The stormwater management goal was to maximize the capacity of the swale system given the existing constraints. The following factors influenced the design:

- Preservation of existing parking spaces was a primary goal.
- Ponding could not be deeper than 6 in. (a requirement of the school district).
- The swale was constrained to a footprint of approximately 1,000 sq. ft. even though the new parking configuration provided significantly more landscape area with which to work. Constraining factors included the existing topography, the space and geometry of the new sidewalk and two parking entrances, etc.
- Even with drainage berms (speed bumps) directing drainage, the topography of the lot results in more than half the runoff entering the middle and lower half of the swale.
- The longitudinal slope of the swale is relatively steep, ranging from 4-7%. The check dams were needed to slow the rate at which runoff moves through the swale.

Grading the swale; August 2002

Installation of log check dams; August 2002

In September 2001 the BES Materials Testing Lab conducted a soil investigation at the site of the swale. Staff augered holes to a depth of more than 10 ft., taking grab-samples at discrete depths. Staff later evaluated the samples for moisture content and mechanical grading, and ran hydrometer tests. The lab characterized the top 5 ft. of soil as "medium stiff silt" with "low to very low permeability" based on its grain-size distribution.

Ponding in the last compartment of the swale in winter - note standpipe

In April 2002 BES Planning staff conducted informal infiltration tests in the soils of the parking lot. Staff augered two holes, each of them approximately 2 ft. deep. The workers filled the holes with water and documented the water level over 30 minutes. In both holes the water level descended 4-5 in. during the interval. Although small-scale infiltration tests are sometimes poor predictors of facility infiltration characteristics, the results suggested an infiltration swale would drain within an acceptable amount of time (less than a day).

Log checkdam holds water back following a storm; November 2002

II. The Components

The Swale

Catchment Area: 9,700 sq. ft. of asphalt
Facility footprint[2]*:* Approx. 1,000 sq. ft.
Internal Volume: 400 cu. ft.
Overflow: The standpipe at the north end of the swale drains to a second stormwater facility (the Glencoe Rain Garden).
Capacity: The swale has less internal volume than the comparable eastside soakage trench[3] that would be required for the same catchment area (the soakage trench would have a footprint of 582 sq. ft. and a volume of 611 cu. ft.).
Additional Information:

Standpipe overflow in the last compartment of the swale

- The swale is approximately 150 ft. long and 6 ft. wide. The average depth is 18 in.; the check dams pond runoff a maximum of 6 in. deep in the compartments.
- The sides have slopes of between 2:1 and 3:1.
- The swale's longitudinal slope is 4-7% (toward the north).
- The overflow elevation at the standpipe (north end of the swale) is 6 in. above the swale floor.
- Two to three in. of compost mulch was applied throughout the swale.
- Slopes at the main stormwater entry points were stabilized with embedded rocks and plantings rather than rip-rap.

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[2]For the purpose of comparing the capacity of the facility with the standard eastside soakage trench, the footprint has been calculated as the wetted (ponded) surface area when the facility reaches maximum capacity.

[3] The standard eastside soakage trench meets the City's standard for complete stormwater disposal in soils, which infiltrate at least 2 in. per hour. The City requires 24 feet of trench per 1000 sq. ft. of impervious area (drainage catchment). The trench is 3 ft. deep, 2.5 ft. wide, and filled with drainage rock. Flow enters the trench through a pervious pipe that travels the length of the top of the trench. Assuming a porosity of 35%, the trench provides an internal volume of approximately 63 cu. ft. per 1000 sq. ft. of catchment.

Landscaping

- There is a total of 4,600 sq. ft. of landscaping (includes the stormwater swale).
- There are four planting zones:
  - The bottom of the swale was planted with native rushes and sedges, and over-seeded with a native wetland grass mix.
  - The swale side-slopes were planted with a mix of shrubs, perennials, groundcovers, and grasses. The mix is half native and half ornamental; the plants were selected for low maintenance requirements in dry and exposed conditions.
  - The plantings outside the swale - approximately 3,000 sq. ft. on the east and north sides - consist of low-maintenance shrubs and groundcovers.
  - The grassy median between the sidewalk and street receives runoff from the adjacent sidewalk. Four Douglas firs were planted in the median to demonstrate the benefits of evergreen street trees.
- Twenty-four trees were planted: ten Red Maples, one Dogwood, nine Vine Maples, and four Douglas Firs.
- The swale is irrigated as needed in summer with a system of soaker hoses. The trees are irrigated by hand or with irrigation bags. Little irrigation should be needed after the plants are established.

Speed Bumps

Two drainage berms (speed bumps) cross the parking lot from east to west, diverting runoff into the swale. They are 12 in. wide and 2 in. high. Without the berms, most of the runoff would enter the lower end of the swale. Runoff along the west side of the parking lot is also diverted into the swale by raised parking stripes. The stripes were painted with thermoplastic paint, raising them to approximately 0.25 in.

The parking lot prior to construction, June 2002.

Parking lot following construction and planting, October 2002.

The parking lot in spring 2003, approximately 6 months after construction..

Budget

BES developed the following budget. It is based on BES staff time for project design and management as well as charges from Portland Parks and Recreation for project construction. The estimated project cost was $93,858.

Glencoe Swale Summary Budget		
Task	**Item Cost**	**Total Cost**
Overall project management		$5,500
Design		$10,419
Construction management, inspection		$9,200
Demolition, grading, site prep		$26,040
Construction		$25,608
Sidewalks, Driveways	$10,000	
Bridge, Curbs, Curb Stops, Asphalt Patches	$14,808	
Piping (overflow)	$800	
Landscaping		$15,991
Plants	$5,806	
Plant Installation	$6,585	
Irrigation	$300	
Parks Overhead Charges (4%)	$3,300	
Miscellaneous		
Permitting	$1,100	$1,100
TOTAL		**$93,858**

I. Budget Elements

Non-construction Activities
The total estimated cost for management, design, and permitting was $26,219, comprising approximately 28% of the total budget.

- **Management (Project and Construction Management)**
  The total cost for both project and construction management was approximately $14,700, comprising approximately 16% of the total budget.

- **Design**
  The total cost for design was approximately $10,419, comprising approximately 11% of the total budget.

- **Permitting**
  Permitting costs were $1,100, comprising approximately 1% of the total budget.

Construction Activities

Excavation, grading, construction, and landscaping costs totaled $67,639, comprising 72% of the total budget.

The parking lot and swale; October 2003

- **Demolition, Excavation, and Grading**
  The total cost for demolition, excavation, and site preparation was $26,040, comprising approximately 28% of the total budget.

- **Construction**
  The total cost for construction was $25,608, or 27% of the total budget (80% of the construction budget). The cost includes construction of the sidewalks, parking lot entrances, curbing, and the bridge over the swale.

Berm (Speed bump) across parking lot to divert runoff into the swale; September 2002

- **Landscaping**
  The project included approximately 4,600 sq. ft. of landscaping at a cost of $15,991. This figure includes material, labor, and PP&R overhead charges for purchase of trees ($3,300). Landscaping costs were 16% of the total budget, with a unit cost of approximately $3 per sq. ft.

II. Cost Components

Raised parking stripe directing runoff into the swale; November 200.

Concrete Work: The concrete work was extensive. Elements included:

- Sidewalks - 1,000 sq. ft.
- Two parking lot entrances - 1,500 sq. ft.
- A bridge across the swale (the main access from the parking lot to the school entrance).
- Standard 6 in. curb - 135 lineal ft.
- Extruded 6 in. curb - 70 lineal ft.

All of the concrete elements were essential to the project, either to meet City standards or as a functional element (e.g. the bridge). The concrete work was by far the biggest component of the construction budget – replacement of the sidewalks and entrances alone cost $10,000.

Hourly Labor Rate: The City of Portland designed and built the project. BES staff designed it and contracted with Portland Parks and Recreation (PP&R) for its construction in a “design/build” approach. Time constraints made construction with City crews the only viable option. However, costs for City construction labor were likely higher than what is typical in the private sector: the average rate for non-engineering construction staff was approximately $55/hr (includes equipment and overhead).

Sequencing of Tasks: The short construction schedule resulted in less-than-optimum sequencing of certain tasks. Examples:

- Workers spent extra time working around un-cured concrete; the schedule would not allow the normal delay in work needed for curing.
- The swale had to be graded a second time after its completion: extensive erosion occurred after the initial grading effort due to pressure washing of the parking lot. Pressure washing was part of the preparation for painting the parking lot.

Asphalt Demolition Work: Removal of 4,600 sq. ft. of pavement and underlying subgrade was likely a major project expense although it could not be identified in the budget as a separate line-item.

III. Cost Comparisons

The parking lot retrofit project required little pipe work and incurred relatively modest landscaping costs (based on unit cost and as a percentage of the total budget). Other alterations were more extensive and costly, most notably the concrete elements. This project may be considered an example of a relatively complex, expensive retrofit. However, the cost for similar projects could be significantly lower if bid through the private sector and if planned and implemented with adequate schedule. (see "Successes and Lessons Learned").

Maintenance and Monitoring

BES will maintain the swale through September 2006, the end of the start-up period. After that date the landscape will be the responsibility of Portland Public Schools. BES will monitor the performance of the facility for at least five years, and perhaps longer. Confirming the hydraulic performance of the facility will be a primary focus. BES will also regularly evaluate the level of effort required to maintain the facility, the success of the planting regime, and comments from the school district as well as school staff.

Successes and Lessons Learned

Compressed Schedule and Cost-effectiveness: The coordination and sequencing of tasks was extremely challenging because of the short construction schedule. The design/build approach provided needed flexibility, but it couldn't compensate for all of the planning and logistical challenges associated with the short timeframe. The conditions were not ideal for minimizing costs.

Preservation of Parking Spaces: The project illustrates how parking lots can be retrofit with stormwater facilities without substantially reducing the number of parking spaces (the number of parking spaces was reduced from 38 to 35).

Applicable City Standards: The project is an example of the extensive measures sometimes required to bring old parking lots into conformance with current standards. The main example in this project was the need to install sidewalks along two sides of the parking lot (none existed previously).

Successful Construction Methods:

- *Management of Sheet Flow*. The speed bumps and raised parking stripes have proved to be an effective (and inexpensive) way to direct runoff into the swale. Without these changes, more than half of the runoff would drain into the bottom of the swale.
- *Erosion Control*. Simple protection measures for the swale sides – a combination of plantings interspersed with embedded rocks – proved to be an effective, attractive, and low-cost alternative to traditional engineering approaches such as rip-rap.
- *Check Dams*. The logs are attractive and they were inexpensive. However, substantial effort was required to level them and secure them in place. It's difficult to adjust them post-construction, and they've attracted undesirable foot traffic (pedestrians sometimes find them easier to use than the bridge).

Swale Bridge: The original design called for a swale depth of just 10 in., which addressed the school's safety concerns and allowed adequate stormwater capacity. During construction the design changed when it became clear that the bridge footing would require a depth of 18 in. It's a lesson learned to conduct an early review of all the factors that might influence the depth of landscape facilities.