DaVinci Living Water Garden Project

2508 NE Everett Street, Portland

Project Summary

Project Type:	Commercial stormwater retrofit – demonstration project
Technologies:	Landscape infiltration basin; lined pond; vegetated infiltration swales; water harvesting cisterns; downspout disconnections.
Major Benefits:	• Runoff from more than 14,000 sq. ft. of roof and pavement surface has been removed from the sewer (in part due to the removal of 7,200 sq. ft. of impervious surface). • The stormwater facilities remove more than 314,000 gallons of runoff from the sewer in a typical rain year, with corresponding reductions in stormwater pollutants. • The project added 4,700 sq. ft. of native landscaping, creating an outdoor classroom and improving the urban environment.
Cost:	$78,729 (unit cost of $5.50/sq. ft. of impervious area). The cost includes volunteer hours as well as some components that were not essential to the stormwater management goal (e.g. rain harvesting system, a bridge, walkway and gazebo). Environmental Services provided a $30,000 grant for the project.
Constructed:	Fall 2002

Project Background

The students and teachers at DaVinci Arts Middle School began an interdisciplinary exploration of water in 2000. The exercise led to a multi-faceted stormwater project to construct the Living Water Garden on the south side of the school. The goals were to create a garden to manage runoff from adjacent impervious areas and celebrate the aesthetic qualities of water. The school also wanted to develop a living laboratory for the natural sciences and a community amenity. More than 350 students contributed to the project, supported by teachers, parents, and local design and engineering professionals. The community undertook the project in collaboration with Urban Water Works (UWW), a non-profit organization. UWW provided technical support, coordinated grant applications, and managed the project.

Excavation of the project in 2002. Note the outlines of the stormwater features (SE corner) and the catchment areas (adjacent classrooms and parking lot).

UWW applied to the Willamette Stormwater Control Program[1] in April 2002. The program accepted the project for funding based on its stormwater reduction goals. The project received additional grant funds from the U.S. Fish and Wildlife Service (through Metro Regional government), the City of Portland's Office of Sustainable Development, and private donations.

[1] Portland's Bureau of Environmental Services 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 system. The Program provided grants for eleven projects. All were completed by July 1, 2003.

Project Scope

- Removed the 7,200 sq. ft. concrete tennis court.
- Excavated and relocated soil to create a water garden featuring a lined pond, a vegetated swale, a landscaped infiltration basin, and two water harvesting cisterns.
- Disconnected downspouts from adjacent school buildings (portables) and replumbed the pipes externally to discharge roof runoff to the water garden.
- Constructed an outdoor amphitheater, a bridge, a gazebo, and walkways.

View of the permanent pond, cisterns, and classroom buildings; November 2003

Notable Features

- Two aboveground cisterns store 5,000 gallons of stormwater. They supply the pond and the majority of summer irrigation needs in the Water Garden.
- The lined pond provides stormwater storage year-round.
- Flowforms[2] aerate and revitalize recirculating pond water. They also provide a pleasant audible and visual element.
- Artistic elements include student-made ceramic tiles and animals, art displays attached to the fence, two commemorative benches, and a "cob" (adobe-like) gazebo.

Looking north across the water garden; the edge of the amphitheatre and the gazebo are in the foreground; November 2003.

Project Design

The project took two years to design. UWW coordinated the process, incorporating input from students, teachers, parents, local residents, and design professionals. A community design charette in 2001 was an important element in the formulation of the water garden concept.

Overview of the Stormwater System

- Runoff from approximately 5,300 sq. ft. of roof drains to the water garden; 2,840 sq. ft. is directed to the cisterns and 2,640 sq. ft. drains directly to the lined pond.
- Overflow from the pond is directed to a vegetated swale ("main swale"), which drains to the landscaped infiltration basin ("wetland").
- About 4,600 sq. ft. of parking surface drains to the water garden via a vegetated infiltration swale ("secondary swale"), which drains to the main swale.
- Overflow from the landscaped infiltration basin drains to a soakage trench located in the adjacent playing field.

[2] A flowform is a series of sculpted bowl-like forms creating a cascade effect that cleans and oxygenates flowing water. More details can be found on the internet.

System Components and Stormwater Capacity

I. Introduction

The overall stormwater management goal was to meet the Bureau of Development Services (BDS)[3] standards for stormwater disposal. When BDS approved the project in 2002, the disposal standard was to infiltrate at least 3 in. of runoff in 24 hours (approximately the size of the 10 year design storm). All design standards cited in this report were current in 2002

City permitting staff did not require site-specific infiltration tests; local drainage characteristics had already been documented adequately by other projects in the vicinity[4]. The Natural Resource Conservation Service (NRCS) Soil Survey for Multnomah County describes the soils as "very well draining". The Survey classifies the soils as 51B - Latourell complex with an infiltration rate of 0.6 – 2.0 in. per hour.

View of the tennis court, marked with features of the future Water Garden; 2001

Hand excavatiaon of the features; 2002

Laying the liner for the permanent pond; 2002

II. Facility Components

Landscape Infiltration Basin (the "wetland")

Catchment Area: Approximately 9,900 sq. ft**.** of roof and parking lot surface.

Facility footprin[5]*t*: Approximately 594 sq. ft.

Internal Volume: Approximately 600 cu. ft.

Overflow: Overflow from the basin is directed to a soakage trench.

Capacity: The basin has a capacity comparable to the standard eastside soakage trench[6] that would be required for a catchment of 9,900 sq. ft. (the standard trench would have a footprint of 600 sq. ft. and an internal volume of 630 cu. ft.

Additional Information:

- The basin is 18 ft. by 33 ft., with 4:1 side slopes and a ponding depth of 18 to 20 in.
- The infiltration basin, located in the southeast corner of the water garden, receives overflow from the pond as well as runoff from the parking lot.

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[3] BDS is responsible for developing standards for stormwater disposal and inspecting projects to confirm compliance with those standards.

[4] It's common for BDS to require infiltration tests prior to approving plans for infiltration facilities. Designers should contact BDS before submitting plans in order to determine the type of documentation required.

[5] 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 (overflows).

[6] 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 ft. 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.

Rain Water Harvesting System (Two Cisterns)

Catchment Area: 2,840 sq. ft.
Internal Volume: A total of 5,000 gallons (668 cu. ft.)
Overflow: The system overflows to the pond.
Capacity: Approximately 3 in. of rain will fill the cisterns. The cisterns create storage and supply irrigation water during the dry summer months.
Additional Information:

- The two cisterns sit aboveground.
- The cisterns supply a gravity-fed irrigation system.
- The system does not include a "roof washer."

Just after construction - note landscape infiltration basin in background; January 2003

Lined Pond

- The pond has a volume of approximately 29,000 gallons (3,000 cu. ft.); some capacity is created during the drier months when water losses occur through evaporation and plant uptake.
- The pond measures roughly 35 ft. by 40 ft. and is 3 ft. deep in the center. It is lined with an 8mm waterproof membrane.
- The pond is supplied with runoff from 2,460 sq. ft. of roof as well as overflow from the cisterns.
- A small pump recirculates and aerates water through the flowforms.
- Overflow drains to the main swale.

Classrooms that drain to the Water Garden

The Main Swale

- The swale is 35 ft. long and 3 ft. wide.
- It drains overflow from the pond to the infiltration basin.
- The upper third of the swale is lined with a waterproof membrane in order to create a visible stream during rain events.
- The lower two-thirds are not lined, encouraging stormwater infiltration (although there are no check dams to help retain stormwater).

Classroom from which runoff for the three classrooms drains to the cisterns - note aerial pipes

The Secondary Swale

- Runoff from approximately 4,600 sq. ft. of parking lot drains to the swale, which terminates in the main swale.
- It is 20 ft. long and 5 ft. wide. It is not lined.

Soakage Trench

- The trench is 20 ft long; it has a footprint of 50 sq. ft.
- It accepts overflow from the landscape infiltration basin and provides approximately 60 cu. ft. of internal volume.
- The dimensions are consistent with standards for the eastside soakage trench.

Parking lot area that drains to the Water Garden - note garden fence in background

Downspout Disconnection
Approximately 5,300 sq. ft. of roof area (from four portable classrooms) was disconnected and re-plumbed to drain to the cisterns and pond via external ABS piping (3 and 4 in. in diameter).

Landscaping
The landscape basin and swales are planted with a variety of sedges and rushes that are tolerant of both wet and dry soil conditions. The other portions of the garden include a variety of native trees, shrubs, and groundcovers that have low watering demands.

Irrigation system
Runoff from the cistern is gravity-fed to a standard garden hose that can reach throughout the water garden.

DEQ requires simple registration of all subsurface stormwater disposal systems. See the following web site for current information:http://www.deq.state.or.us/wq/groundwa/uichome.htm


The Water Garden in 2003


Looking down on the cisterns, flow forms, and pond


The flow forms


Looking north from wtihin the landscape infiltration basin; November 2004

Budget

UWW submitted a final budget totaling $78,729 in actual and estimated costs. Donations from teachers, students, members of the community, and professionals covered more than half of the cost of the project.

UWW estimated the value of after-school volunteer efforts using Metro's standard volunteer rates ($6.50 per hour). Volunteer professional services averaged $35-$45 per hour. Consistent with Metro's grant guidelines, UWW did not estimate the value of in-school efforts by students and teachers, although teachers leading club activities after school were paid the regular teaching rate.

The Bureau of Environmental Services (BES) contributed $30,000 in grant funding. The budget does not include the Bureau's program costs for administering the grant or providing limited technical support. The final budget is summarized in Figure 1, and a detailed budget is displayed in Table 1 below.

Da Vinci School Water Garden
Detailed Budget

Item	Item Cost	Total Cost	Value of Pro-Bono Services
Project Management		**$7,000**	$4,400
Design		**$12,104**	
Design Charette	$1,500		
Landscape Design	$4,724		$3,920
Hydraulic Design	$1,800		$1,800
Pond and Wetland Design	$1,400		$1,400
Gazebo Design	$1,200		$1,200
Bridge Design	$400		
Artistic Design	$1,080		
Demolition, grading, site prep		**$5,500**	
Concrete removal	$2,500		
Soil excavation & grading	$3,000		$3,000
Construction Management		**$10,000**	
Construction		**$25,908**	
Labor - parents & students	$11,609		$11,609
Gutter alterations and piping	$1,795		
Cistern with pump, accessories	$2,491		$500
Pond liner and equipment	$2,122		$1,061
Gazebo and benches	$1,634		
Other materials: rock, gravel	$6,257		$1,529
Landscaping		**$13,226**	
Plants and Trees	$12,926		$5,435
Plant Installation	?		
Irrigation system	$300		
Miscellaneous		**$4,991**	
Permitting			
Grading Permit	$436		
Plumbing Permit	$106		
Art and Flowforms			
Art Materials	$2,000		$500
Flowforms	$1,175		$900
Various	$1,274		$758
TOTAL		**$78,729**	**$39,504**

Table 1

I. Budget Elements

Non-Construction Activities
The estimated cost for management, design, and permitting was $29,646, comprising approximately 37% of the total estimated budget.

- **Project and Construction Management**
  The estimated value of project and construction management activities was $17,000, comprising 22% of the total budget. In contrast to the other demonstration projects, a substantial part of the management costs were for managing volunteer crews.

- **Design**
  The estimated value of the design effort was $12,104, comprising 15% of the total cost. In addition to landscape design and engineering services for the stormwater system, there were elements such as a design charette and design of the pedestrian bridge. A number of design professionals provided their services free of charge.

- **Permitting**
  The permits totaled $542.

Construction Activities
The total estimated cost for site preparation and construction activities was approximately $49,085, comprising 62% of the total budget.

- **Demolition, Grading, and Construction**
  The estimated value of site preparation and construction work was $31,408, comprising 40% of the total budget. Site preparation included demolition of the tennis court, excavation, and grading.

- **Landscaping**
  The estimated value of the landscape materials was $13,226, comprising 17% of the overall budget. The students installed the plants during school hours so the budget doesn't include total costs. It is important to note that the landscaping covered more than 5,000 sq. ft. (the footprint of the tennis court minus the pond and amphitheatre).

- **Miscellaneous**
  Miscellaneous costs totaled $4,449, including art materials and the flowforms.

II. Cost Efficiencies

More than half the estimated total value of the project is in pro bono services provided by professionals – landscape designers, engineers, etc. – as well as volunteer laborers from the community. The overall cost of the project is probably much lower than if the organizers had contracted for the services, although management costs for coordinating volunteers were significant.

III. Cost Comparisons

This project marshaled remarkable community support; the scope was much broader than a simple commercial stormwater retrofit project to disconnect runoff from the combined sewer. Although the total cost gives a sense of the scale of the project, the nature of the project and the scale of the volunteer effort probably make it unreasonable to compare costs with anything but similar community projects.

III. Stormwater Rate Reduction

In January 2003, the City's monthly commercial stormwater management rate was $5.54 per 1000 sq. ft. of impervious area. A reduction in impervious surface normally qualifies property owners for an immediate reduction in sewer bills, based on the amount of area removed. Since the City does not apply stormwater charges to public play areas, there is no rate reduction associated with converting the DaVinci tennis court into a rain garden.

View south from the cisterns; October 2004

View north from within the landscape infiltration basin; October 2004

Permitting

Plumbing Permit
The City required a plumbing permit for sub-surface piping such as the soakage trench. City officials did not require a permit for the external piping that conveys roof runoff into the garden; the piping was considered an extension of the gutters and downspouts.

Building Permit and Grading Permit
The City required a commercial building permit for the bridges in the garden. It also required a grading permit, but through an oversight didn't require any other permit. The process normally includes reviews for the adequacy of erosion control and grading plans, a review for compliance with the Stormwater Management Manual (for water quality and flow control requirements), and a review of the capacity of the system if the goal is to provide complete on-site disposal.

Planning and Zoning Review
The City required a zoning inspection fee but the project did not trigger requirements related to conditional uses, non-conforming uses, or overlay districts (trails, e-zones, plan districts, etc.). No reviews were required for transportation, pedestrian, ADA, or seismic issues.

Appeals
The City did not require any permitting appeals.

Construction

The community began construction of the project in March 2002 and completed it in November 2002. Construction followed typical erosion control practices; special attention was given to avoiding compaction of areas designated for infiltration.

Maintenance and Monitoring

Portland Public Schools owns the facility. The Friends of the DaVinci Water Garden, a volunteer community group, will provide upkeep of the water garden. The group includes teachers, students, and members of the community.

Environmental Services will monitor the performance of the facilities at DaVinci Middle School for at least five years and perhaps longer. Confirming the hydraulic performance of the facility will be a primary focus. Environmental Services will also regularly evaluate the level of effort required to maintain the facility, the success of the planting regime, and comments from the owner.

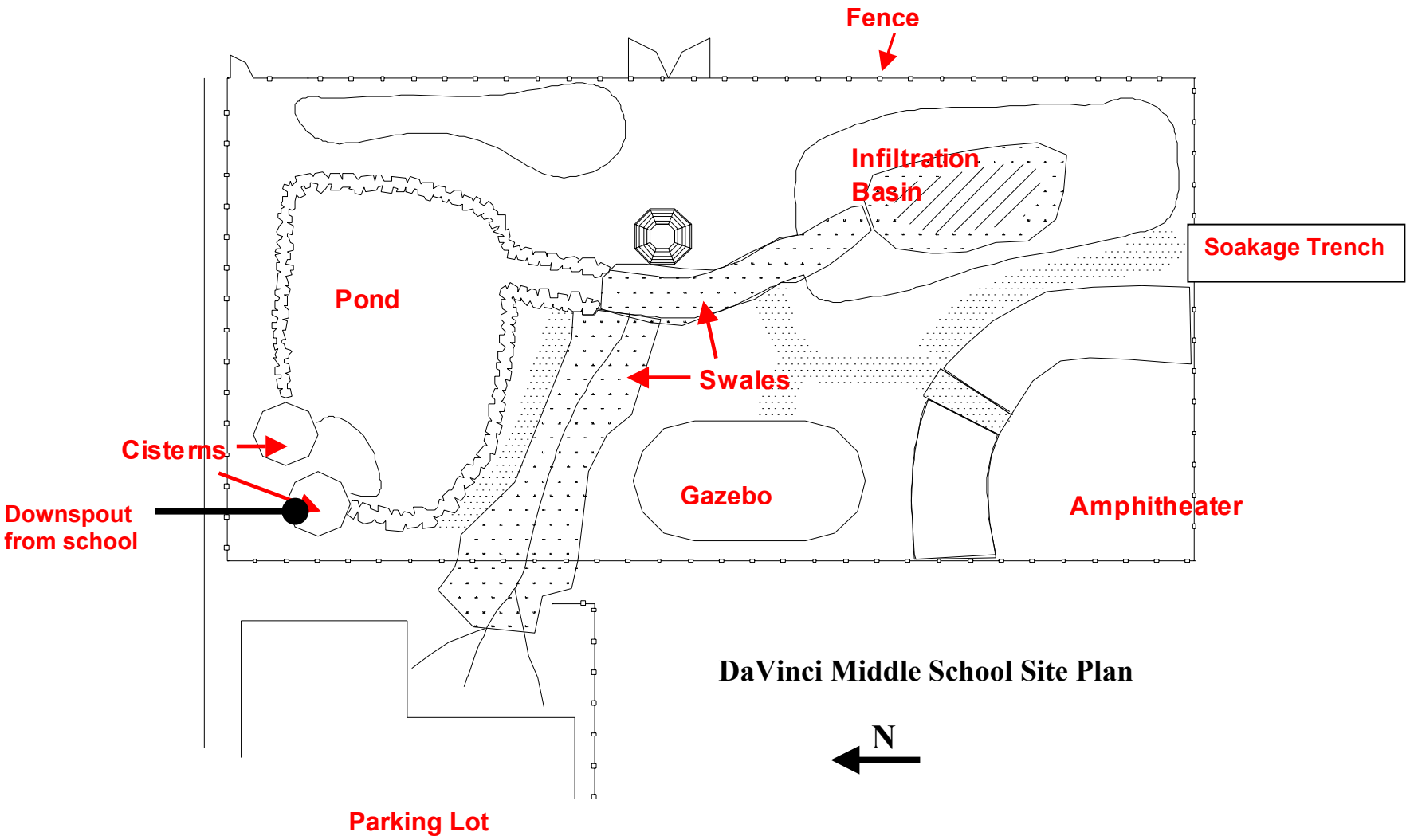
Successes and Lessons Learned

Project Scope – The project is an important asset to the school and the local community. It provides a number of educational, artistic, and environmental resources and it's a great example of the type of stormwater project that has wide appeal and can leverage substantial support from the community. Although the project manages only a fraction of the school's runoff, it is an important model for other stormwater management efforts.

Mix of Professional and Community Services – The project showcases the challenges and potential successes of coordinating services from a range of professionals and volunteers. The project's success reflects the abilities of the organizers, the strong support of the community, and the long design and implementation period. It took three years from inception to completion.

Controlled Access – An open-air water garden without the cyclone fence would have required a somewhat different design. The School District would have allowed just 6 in. of ponded water in the infiltration basin and lined pond, requiring a larger facility to provide the equivalent stormwater capacity. The cyclone fence created an opportunity for deeper, more compact facilities, allowing more room for other activities and uses in the garden.

Stormwater Capacity – Although the capacity of the stormwater system appears to be more than adequate to provide complete on-site infiltration, additional infiltration could be obtained by installing check dams in the swales.


Fence
Infiltration Basin
Soakage Trench
Pond
Swales
Cisterns
Downspout from school
Gazebo
Amphitheater
Parking Lot
DaVinci Middle School Site Plan
N