# Oregon Natural Resources Council

5825 N. Greeley Avenue, Portland

# **Project Summary**

<b>Project Type:</b>	Commercial stormwater retrofit – demonstration project
Technologies:	Porous paver system; landscape infiltration basin; simple downspout disconnections (to splash blocks).
Major Benefits:	<ul> <li>Runoff from more than 13,000 sq. ft. of impervious surface (roof and pavement) has been removed from the combined sewer.</li> <li>The stormwater facilities remove more than 300,000 gallons of runoff from the sewer in a typical rain year, with corresponding reductions in runoff pollutants.</li> <li>The project added 4,700 sq. ft. of native landscaping, improving the aesthetic appeal of the property and benefiting the urban environment.</li> </ul>
Cost:	\$82,946 (unit cost of \$6.00 per sq. ft. of impervious area managed). The total cost includes some components that were not essential to the stormwater management goals (e.g. a rain harvesting system and a bridge). Environmental Services provided a \$30,000 grant.
Constructed:	Fall 2002

# **Project Background**

The Oregon Natural Resources Council (ONRC), a non-profit conservation organization, moved to the site in 1996. ONRC was planning a comprehensive site renovation project in 2001 when it received information about the Willamette Stormwater Control Program<sup>1</sup>. ONRC then contracted with a landscape architect to develop a proposal to completely disconnect the site from the combined sewer system, managing the stormwater entirely onsite. Environmental Services accepted the project into the Program in 2001.

ONRC viewed the project as an opportunity to enhance the site renovation project to better exemplify the sustainability goals of its mission. It wanted to provide an example of the environmental benefits associated with on-site stormwater management, and save money on its stormwater utility bill.



The property in 2002 before the project

12/9/2004; ONRC

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<sup>&</sup>lt;sup>1</sup> 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. The Program provided grant funds for eleven projects. The projects were completed by July 1, 2003.

# **Project Scope**

- Removed all existing asphalt (approximately 9,100 sq. ft.)
- Installed a pervious paver system (5,500 sq. ft. of pavers for the parking lot; 250 sq. ft. for the patio).
- Installed a 1,700 gallon rain harvesting system to provide irrigation water.
- Constructed a landscape infiltration basin to manage roof runoff and any overflow from the paver system.
- Planted almost 5,000 sq. ft. of landscape with native vegetation.
- Re-routed all roof runoff to landscape areas.
- Installed a small bridge and a gravel path.

#### **Notable Features**

- The entire site has been completely disconnected from the combined sewer system.
- The project includes two relatively new technologies a rain harvesting system and pervious paver system.
- Retrofitting the parking lot resulted in the loss of four non-essential parking spaces.
- The large infiltration basin is integral to the landscaping at the building entrance.

# **Project Design**

ONRC contracted with the Lando and Associates, Landscape Architecture Inc. to design the project. The stormwater management goal was to provide complete on-site disposal of all stormwater runoff.

# **Overview of the Stormwater System**

- Approximately 1,200 sq. ft. of the roof on the south side of the building drains to adjacent landscaped areas via splash blocks.
- About 3,200 sq. ft. of roof drains to the cistern buried at the west end of the landscape infiltration basin.
- The cistern overflows to the adjacent landscape infiltration basin.
- The pervious pavers infiltrate all rainfall that lands on the 5,500 sq. ft. parking lot. If the paver system ever reaches capacity, it would overflow to the landscape infiltration basin.



The new sign with the infiltration basin in the background; September 2003



View from the NW corner of the property - note landscape infiltration basin behind wheel stops; February 2003



The walkway and the landscape infiltration basin; June 2004

### **I. Introduction**

The overall stormwater management goal was to meet the Bureau of Development Services (BDS)<sup>2</sup> standards for stormwater disposal. When BDS approved the project in 2002, the disposal standard was to infiltrate at least 3 inches of runoff in 24 hours (approximately the size of the 10 year design storm). All standards cited in this report were current in 2002.

City permit staff did not require site-specific infiltration tests as local drainage characteristics had already been adequately documented by other projects in the vicinity. The Natural Resources Conservation Service (NRCS) Soil Survey for Multnomah County classifies the soils as part of the Latourell Complex. The Survey gives an estimated infiltration range of 0.6-2.0 in. per hour.



(See Site Plan, pg. 6, for more details)

# **Rain Harvesting System**

Catchment Area: 3,200 sq. ft. of roof

*Internal Volume* (empty): 1,700 gallons (227 cu. ft.) *Overflow*: Drains to landscape infiltration basin.

Capacity: A little under an inch of rain (.85 in.) will fill the cistern. The cistern provides stormwater capacity during the drier months when the stored runoff is used to supplement irrigation needs. If plans are realized to reuse stormwater for toilet flushing, the cistern will provide additional runoff capacity even during the months when no irrigation is required.

### Additional Information:

- The cistern is buried at the west end of the landscape infiltration basin.
- The cistern water is distributed for irrigation via a pump after passing through two sediment filters.



Detail of the pavers during construction; October 2002



Installation of the pavers - looking south toward the ONRC office



Excavation of the landscape infiltration basin - note workers applying gravel to paver spaces



Excavation of the landscape infiltration basin

3

<sup>&</sup>lt;sup>2</sup> BDS is responsible for developing standards for stormwater disposal and inspecting projects to confirm compliance with those standards. 12/9/2004; ONRC

# **Landscape Infiltration Basin**

Catchment: 3,200 sq. ft. of roof (runoff enters via the cistern)

Facility footprint<sup>3</sup>: 520 sq. ft.

Internal volume: 660 cu. ft. (includes sub-surface gravel trench)

Overflow: If the basin ever crests in a large storm, it will spill north across the parking lot, away from the building foundation, and fill the sub-base of the paver system before flowing across the surface to the public right-of-way.

Capacity: The basin has a capacity much larger than the comparable standard eastside soakage trench<sup>4</sup> that would be required for a similar catchment. The soakage trench would have a footprint of 192 sq. ft. and an internal volume of 200 cu. ft.

# Additional Information:

- The basin is linear and deep: in the main body of the facility the centerline is about 3 ft. below grade.
- A narrow gravel trench lies under the east part of the facility. It is 20 ft. long, has a cross section of 12 in. by 12 in., and is buried about a foot below the floor of the basin. Neither perforated piping nor filter fabric was used in its construction.

# **Porous Paver System (Parking Lot)**

Catchment: 5,500 sq. ft. (as direct rainfall)

Facility footprint: 5,500 sq. ft.

*Internal volume*: 1,650 cu. ft. (as pore space in the gravel sub-grade).

Overflow: The bottom of the gravel layer under the pavers slopes gently toward the adjacent landscape infiltration basin. While the paver system has an enormous capacity for runoff, overflows to the basin are possible.

Capacity: The system has an extremely large internal volume compared to the standard eastside soakage trench<sup>4</sup> that would be required for a catchment of 5,500 sq. ft. (the soakage trench would have a footprint of 330 sq. ft. and an internal volume of 345 cu. ft.).

# Additional Information:

- The pavers are 8 in. square and 3 in. thick.
- They are constructed of concrete and recycled fly ash.
- They are set in one inch of pea gravel with an 8-inch sub-base of crushed rock.
- They were supplied by SF-Rima <sup>TM</sup> (by WestCon).
- The parking lot is pitched slightly toward the infiltration basis, so if rainfall exceeds the infiltration rate, it will seep into the basin.



The landscape infiltration basin with final grading; October 2002



Arrival of the cistern



Installation of the cistern; October 2002

<sup>&</sup>lt;sup>3</sup> 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.

<sup>&</sup>lt;sup>4</sup> The standard eastside soakage trench meets the City's standard for complete stormwater disposal in soils which infiltrate at least 2 inches 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 1,000 sq. ft. of catchment.

# **Downspout Disconnections**

There are nine downspouts on the building. Six of the downspouts drain approximately 3,200 sq. ft. of roof, sending runoff to the cistern. Three downspouts on the south side of the building have been disconnected to splash blocks, draining to the adjacent landscape.

# **Emergency Overflow**

If the basin ever crests in a large storm, it will spill north across the parking lot, away from the building foundation, and fill the sub-base of the paver system prior to flowing across the surface to the public right-of-way.

# Landscaping

Most of the plants are natives selected from the plant list in the Environmental Services Stormwater Management Manual. The plantings meet manual requirements for size and spacing. The designer selected species such as Red Osier Dogwood that grow relatively tall and respond well to pruning.

# **Irrigation**

The project included installation of a new permanent irrigation system with pop-up spray heads. It serves a total of 4,700 sq. ft. of landscape with water supplied by the cistern as well as City water (as needed).

# **Other Components**

A gravel walkway provides handicap access to the front entrance as required by City code. The gravel walkway was easily integrated into the landscape and provides a pervious surface at a lower cost than pavers or other Americans With Disabilities Act (ADA)- approved material. The bridge over the north end of the landscape infiltration basin connects the parking lot with the primary building entrance.



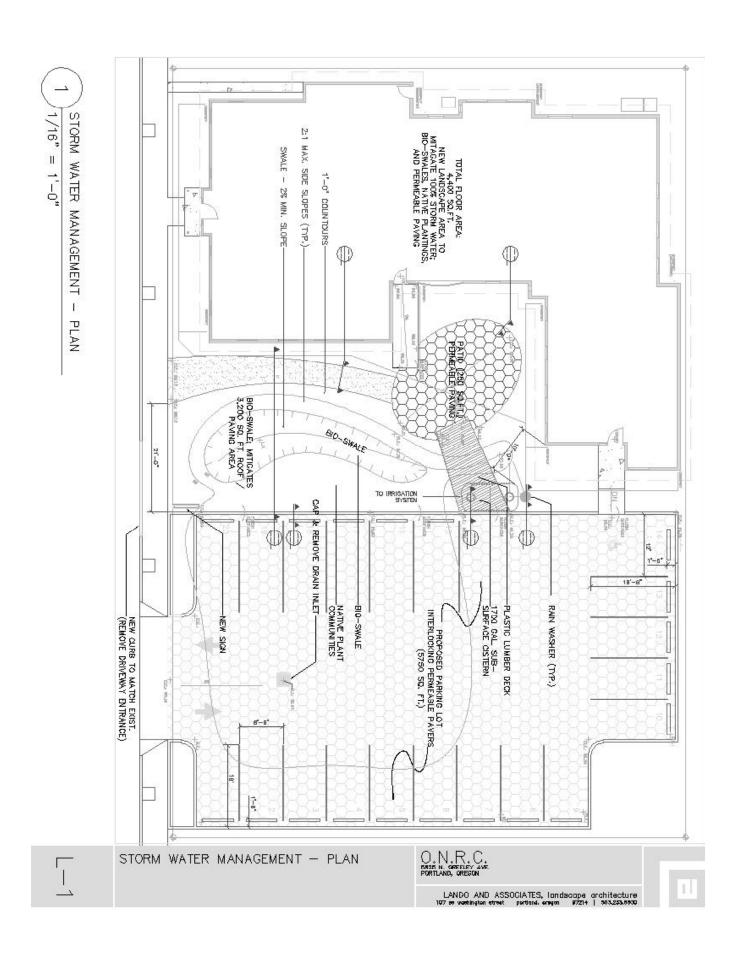
Installation of rain drains within two feet of fourndation; October 2002



Newly planted infiltration basin after rain; January 2003



Newly planted infiltration basin after rain; January 2003



# Budget

ONRC provided the budget, which is detailed on the following page. The total cost for the project was \$82,946 including management, design, and construction.

BES contributed \$30,000 in grant funds to the project. Bureau costs for administering the grant program and providing limited technical support are not included in the budget.

# **Costs For Parking Lot Paver System**

Parking Lot Paver System – 5,500 Sq. Ft.	Cost
Asphalt demolition, removal, export*	\$ 770.00
Excavation - parking lot subgrade	\$ 3,693.00
Sub-base - import and compact (8in.)	\$ 3,400.00
# Pavers - 9790 SF-RIMA pavers *	\$ 8,910.00
Installation - contractor labor	\$ 10,378.00
Installation - volunteers @ \$10 per hour	\$ 936.00
Survey, setting bed	\$ 985.00
Erosion Control*	\$ 825.00
Wheel stops (7)	\$ 277.00
Paver protection - plywood rental	\$ 20.00
Total	\$ 30,194.00
Cost Per Sq. Ft.	\$ 5.49
* Calculated as a portion of a larger cost	

**ONRC Budget Summary** 

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Item	Item Cost	<b>Total Cost</b>	In Kind Cost
Project Management		\$ 10,957.00	
General management (ONRC)	\$ 9,367.00		
Contract management (L.A.)	\$ 1,590.00		
Design		\$ 2,359.00	
Demolition, excavation, grading		\$ 13,441.00	
Asphalt demo, removal, export (9100 sq. ft.)	\$ 1,325.00		
Excavation - parking lot subgrade (6in. depth)	\$ 3,693.00		
Excavation & grading - swale, patio, walk	\$ 3,140.00		
Excavation - trenching for rain drains	\$ 693.00		
Remove catch basin, cap line	\$ 250.00		
Equipment rental	\$ 400.00		
Excavation, etc cistern	\$ 1,720.00		
Erosion control	\$ 1,365.00		
Miscellaneous (waste export, recycling, etc.)	\$ 855.00		
Construction Management		\$ 2,634.00	
Construction:		\$ 31,568.00	
Paver System & Patio - 5,750 sq. ft.			
Sub-base - import and compact (8 in.)	\$ 3,400.00		
Pavers - 10,240 sq. ftRima <sup>TM</sup> pavers	\$ 9,357.00		
Installation - contractor labor	\$ 10,378.00		
Installation - volunteers	\$ 936.00		\$ 936.00
Survey, setting bed	\$ 985.00		
Wheel stops (7)	\$ 277.00		
Paver protection - plywood rental	\$ 20.00		
Subtotal	\$ 25,353.00		
Bridge			
Fittings for bridge & ramp	\$ 500.00		
Plastic decking	\$ 1,072.00		
Subtotal	\$ 1,572.00		
Rain Water Harvesting System			
Concrete Cistern	\$ 1,850.00		
System Pump	\$ 1,086.00		
Piping	\$ 976.00		
Electrical irrigation controls	\$ 731.00		
Subtotal	\$ 4,643.00		
Landscaping (4,670 sq. ft.)		\$ 16,058.00	
Installation - contract labor, mulch, etc.	\$ 3,280.00		
Transplant existing plants	\$ 600.00		
Installation - volunteer labor (\$10/hr)	\$ 320.00		\$ 320.00
Irrigation	\$ 5,891.00		
Plant material	\$ 5,967.00		
Miscellaneous:		\$ 5,929.00	
Permitting			
Coordination of submittal and appeal	\$ 2,865.00		
Permit - Planning/Zoning/Land use	\$ 1,369.00		
Permit – Environmental Services	\$ 787.00		
Permit - Plumbing	\$ 423.00		
Maintenance agreement	\$ 248.00		
Subtotal	\$ 5,692.00		
Other			
Porta-potty rental	\$ 187.00		
Handicap paint and signage	\$ 50.00		
Subtotal	\$ 237.00		
TOTAL		\$ 82,946.00	

### **I. Budget Elements**

#### **Non-construction Activities**

The total estimated cost for management, design, and permitting was \$21,642, comprising approximately 26% of the total budget.

# • Project and Construction Management

The total for project and construction management was \$13,591, comprising 16% of the total budget. Two ONRC staff managed the project, providing a total of 540 hours of effort over 18 weeks. They managed the budget, worked as liaisons between the designer and subcontractors, and scheduled volunteer labor. Management also includes the landscape architect's time for managing the contract and overseeing construction.

#### • Design

The landscape architect's cost for designing the project was \$2,359, comprising 3% of the total budget.

## Permitting

Permitting costs, including the labor costs to coordinate the original submittal and appeal, were \$5,692, comprising almost 7% of the total budget.

#### **Construction Activities**

Demolition, excavation, construction, and landscaping costs totaled \$61,304, comprising 67% of the total budget. The paver system for the parking lot is the largest single component, comprising 80% of total construction costs (see Table 2 at the end of this section). The rainwater harvesting system, including the cistern and related components, comprises 15% of the construction budget.

#### Demolition, Excavation, and Grading

The site preparation activities, including removal of the existing asphalt (9,100 sq. ft.), cost \$13,441, comprising 16% of the total budget.

#### Construction

The core construction activities, including installation of the paver system, the rainwater harvesting system, and the bridge cost \$31,568, comprising 38% of the total budget.

# Landscaping

The project included almost 5,000 sq. ft. of landscaping (about one-third of the total site). It cost \$16,058, comprising 19% of the total budget.

# **II. Cost Efficiencies**

#### **Paver System**

The cost of the porous paver system was \$5.49 per sq. ft., including demolition and recycling of the existing asphalt, excavation, and installation of an 8-in. sub-base of crushed rock. The unit cost for the paver system is likely lower than typical since ONRC purchased the pavers at a discounted rate.

### **Plumbing**

Extensive sub-surface piping was needed to extend the building's downspouts to the cistern. The parking lot retrofit required only the capping of the existing stormwater inlet. The landscape infiltration basin did not require any piping for overflow events.

### Landscaping

Although the overall cost of landscaping was a significant budget component, the unit cost of purchasing and installing the plants was relatively low at \$2.00 per sq. ft. The permanent irrigation system added substantially to the total landscaping budget, costing an additional \$1.21 per sq. ft.

# **Asphalt Removal**

The unit cost for removing and exporting 9,100 sq. ft. of asphalt was \$0.15 per sq. ft. for a total cost of \$1,325. That includes removal of the sub-grade, which was "almost non-existent" according to the landscape architect.

### **III. Cost Comparisons**

This project is a good example of the type of intensive retrofit that a long-term property owner might undertake as part of a substantial renovation project. While part of the runoff is managed in a simple landscape system, the budget is dominated by the installation of the paver system. The stormwater harvesting system also makes this a more complex, costly retrofit. It is clear that for some property owners the many long-term benefits associated with these approaches outweigh their costs relative to simpler stormwater management approaches.

# **Bidding and Permitting**

#### I. Bidding

ONRC contracted directly with Lando and Associates, Landscape Architects Inc. for design and construction management for the project. Lando and Associates coordinated the work schedule and approved the completion of work for each sub-contractor.

### **II. Permits**

#### **Plumbing Permit**

A plumbing permit was required for the following: disconnecting the downspouts; installing the subsurface rainwater harvesting cistern; installing the backflow prevention and irrigation system; and removing and capping the stormwater inlet in the parking lot.

### **Building Permit**

The City issued a commercial building permit for the project because it was part of a larger renovation project. The process included reviews for the adequacy of erosion control and grading plans, a review for compliance with the Environmental Services Stormwater Management Manual (for water quality and flow control requirements), and a review for the capacity of the system since the goal was to provide complete on-site disposal.

#### **Planning and Zoning Review**

Due to the cost of the renovation project, the City required ONRC to meet current parking lot standards for setbacks and landscaping. The project did not trigger other requirements related to conditional uses or

overlay districts (such as trails, e-zones, plan districts, etc.). No reviews were required for transportation, pedestrian issues, or seismic issues. A review for ADA access was required.

## **Appeals**

An appeal was required for the gravel path between the building and the infiltration basin. The City required a special review for the gravel walkways due to concerns about slope, gravel movement/failure and the safety of wheelchair access. The City also required an appeal for the commercial installation of a rain harvesting cistern. Note: rain washers (to treat the first flush of roof runoff) were not required because the cistern water will be used for landscaping. Rain washers will be required if the water is used for indoor applications.

# **III. Permitting Issues**

The City expressed initial concern about the lack of a piped emergency overflow for the landscape infiltration basin. ONRC then doubled the capacity of the basin and demonstrated that if it ever reaches capacity it will overflow to the pervious parking lot without threatening any structures. City inspectors confirmed that the paver system was installed consistent with the manufacturer's guidelines – the City did not have standards for paver systems at the time of the project.

### Construction

#### I. Summary

ONRC contracted for the installation of the pavers in the parking lot and patio, although a volunteer labor force provided some assistance. Volunteers also helped with installation of the landscape. ONRC staff helped oversee the work and acted as a liaison to the designer. Construction began in September 2002 and was completed in December 2002.

#### II. Issues

Paver protection - After the pavers were installed, the parking lot continued to serve as a staging area for other construction activities. To ensure the paver system was protected during construction, ONRC covered the pavers with plywood and tarps to prevent sedimentation and clogging.

Rain harvesting system – The original plans specified a plastic cistern, however a decision was made in the field to replace it with a concrete cistern in order to accommodate discrepancies between survey information and actual field elevations. There were also concerns about the buoyancy of a plastic cistern and resistance to vehicle load (the cistern sits next to the parking lot). The concrete cistern required an additional 16 in. of depth to provide clearance for its overflow pipe. The difference resulted in a corresponding deepening of the landscape infiltration basin.

# **Maintenance and Monitoring**

ONRC owns the facility and is responsible for maintenance. BES will monitor the performance of the facilities at ONRC for five years or more. Confirming the hydraulic performance of the facility will be a primary focus. The Bureau will also regularly evaluate the level of effort required to maintain the facility, the success of the planting regime, and comments from the owner. ONRC staff has volunteered to gather information about how visitors are influenced by the project and how they incorporate similar techniques at their own sites.

# Successes and Lessons Learned

<u>Good design</u> – The landscape infiltration basin is an integral part of the surrounding near the building's entrance. The project demonstrates that stormwater management features can be integrated into attractive landscape areas rather than being designed as "facilities" relegated to peripheral areas.

Overall demonstration value – The project provides an example for others interested in similar projects. In addition to being an important educational tool that advances the City's interests in sustainable site design, the project provides important lessons about the challenges of integrating new technologies given the existing City codes.

<u>Space-efficiency of the paver system</u> – This project demonstrates the space-efficiency of pervious parking surfaces. They do not require additional adjacent areas for stormwater treatment and disposal.

<u>Pavers and clogging during construction</u> – The project confirmed the paver systems may be vulnerable to clogging as a result of construction activities, and that protecting the pavers should be a priority for any paver installation project.

### Downspout rain drain pipes

A couple of the downspouts are more than 40 ft. from the rain harvesting system (cistern) to which their drainage is piped. The designer successfully kept the pipes at an acceptable elevation by positioning them within two feet of the foundation for most of the distance. At the time the project was implemented the City allowed stormwater pipes within two feet of a foundation at grades of less than 1%.

<u>Owner motivation</u> – ONRC viewed the project as an opportunity to support its environmental mission, improve the neighborhood, and reduce its stormwater utility bill.

