LID and LEED at Wetland Studies and Solutions, Inc.

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Wetland Studies and Solutions, Inc.

Natural & Cultural Resource consulting firm

75 Staff:

- Archeology;
- Engineering;
- Environmental Science & Ecology;
- Environmental Technology;
- Compliance;
- GIS;
- Regulatory;
- Surveying;
- Wildlife Biology

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The Basics of LID

- **Conservation and protection** of natural features that provide stormwater control.
- **Minimization** of impervious areas and impacts to natural areas.
- **Direction of runoff** to natural areas to slow down and capture water so it can infiltrate natural areas, evaporate, or be reused.
- Use of **multiple small-scale controls** that reproduce natural hydrologic processes including infiltration, detention, retention, evaporation, and groundwater recharge.
- **Pollution prevention** through erosion and sediment control and prevention of soil compaction during site preparation and construction.
- **Education** regarding the importance, implementation, and maintenance of low-impact stormwater management techniques.

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Why Did Wetland Studies Implement LID?

- WSSI's building is serviced by an existing regional pond
  - No on-site stormwater management is required

- Why Implement LID?

  - Mimic predevelopment hydrology, minimizing Urban Stream Syndrome

  - Satisfy our curiosity:
    - To see how different types of pervious pavement systems perform relative to their cost
    - To determine the actual maintenance requirements of an LID project
    - To determine the *real* cost of an LID project
    - To determine the barriers to LID implementation

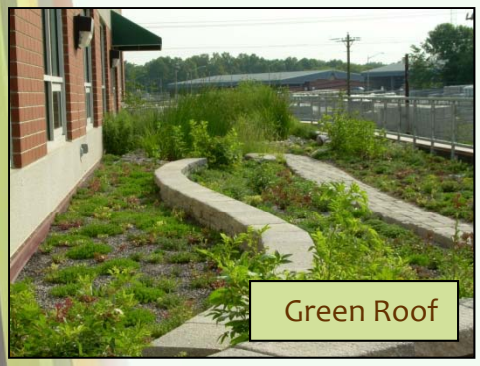
  - Provide a laboratory for the study of LID performance

  - Create an integrated LID plan, rather than using a slapdash approach to LID

How Can LID Help?

- **Reduce both runoff and potable water demand** by using rainwater on-site in toilets and irrigation.
- **Reduce the post-development curve number** to the pre-development curve number by using permeable paving surfaces.
- **Minimize the effect of increased runoff volume on downstream waters** by reducing the post-developed runoff rate below the pre-developed, forested rate through increased storage and time of concentration.
- **Comply with Chesapeake Bay Preservation Ordinance and stormwater management ordinance regulations** without a conventional stormwater management/BMP facility.

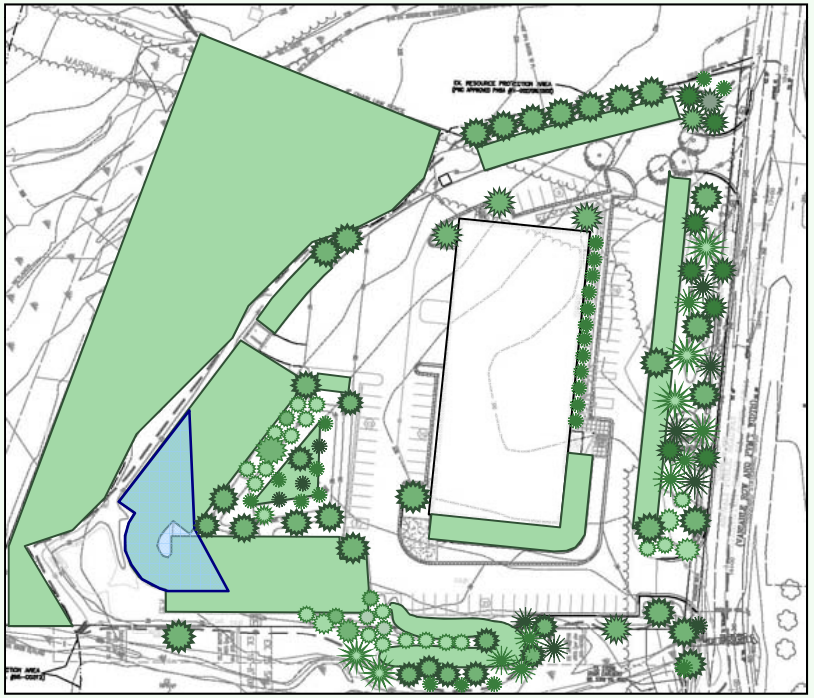
Implementation at WSSI


Green Roof


Naturalistic Landscape


Pervious Parking


Irrigation and Toilet Cisterns




Gravel Detention


Rain Garden


Water Quality Swale

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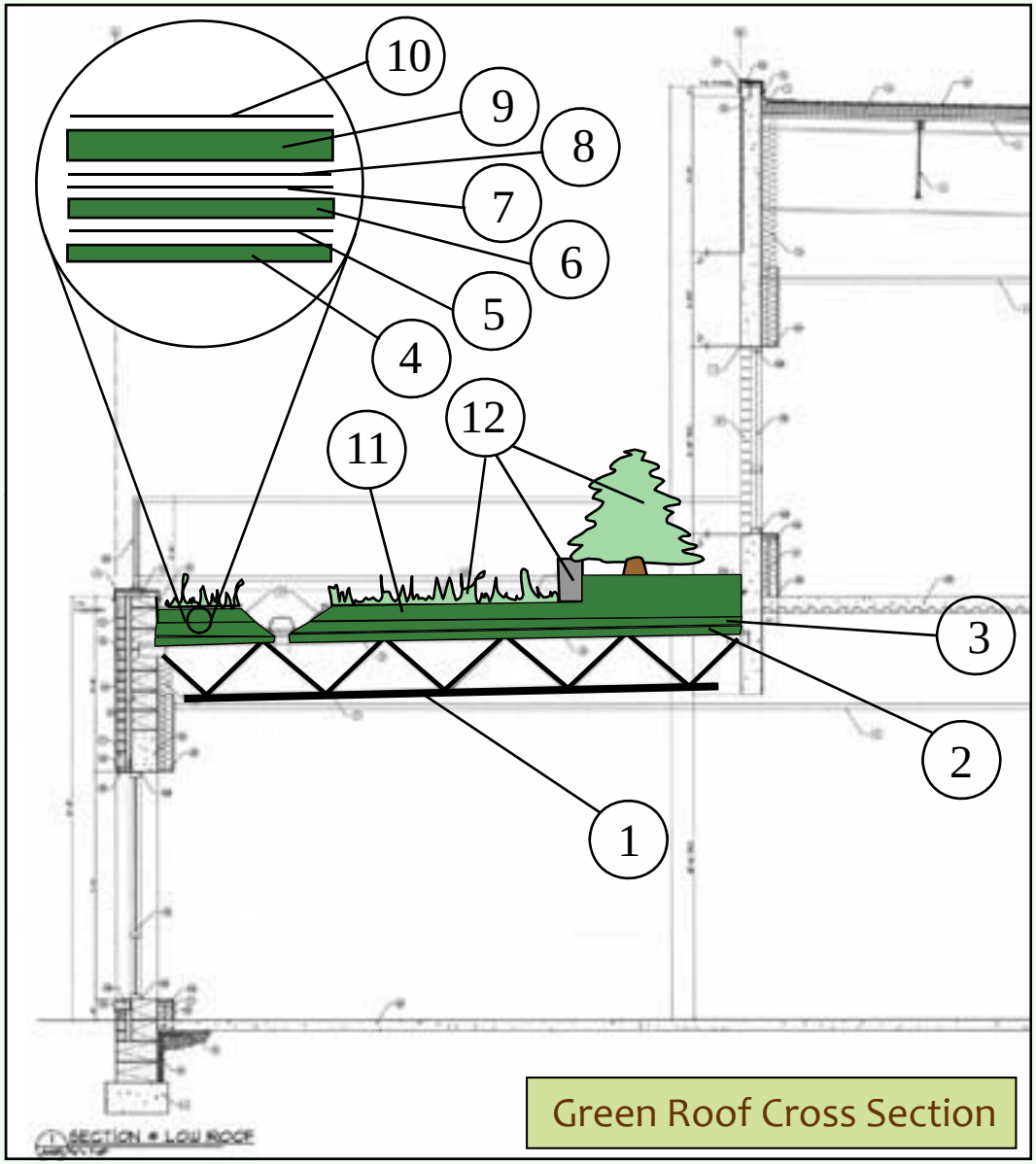
The Green Roof

1. Steel joists
2. Metal roof deck
3. 5” R-30 foam insulation
4. ½” gypsum protection board
5. 75 mil ethylene propylene diene monomer (EPDM) membrane
6. ½” foam protection board
7. 40 mil high-density polyethylene (HDPE) root barrier
8. Protection fabric
9. 1” drainage layer
10. Filter fabric
11. 3-9” lightweight growing medium
12. Stone features, sedum, and native perennials and shrubs



Green Roof Cross Section

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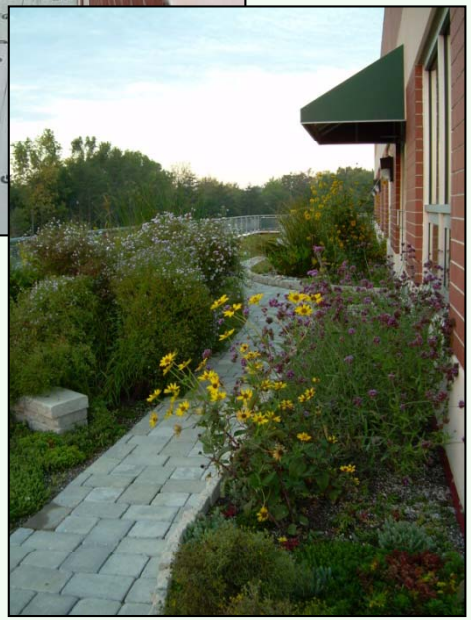
The Green Roof

- Combination of extensive (3-4” soil) and intensive (4-9” soil) planting areas
- Reduces impervious area by 3,626 sf
- Reduces roof runoff
- Engineered to support 62 lbs/sf
- Increases green area and provides amenity
- Cost: $31.80/sf installed



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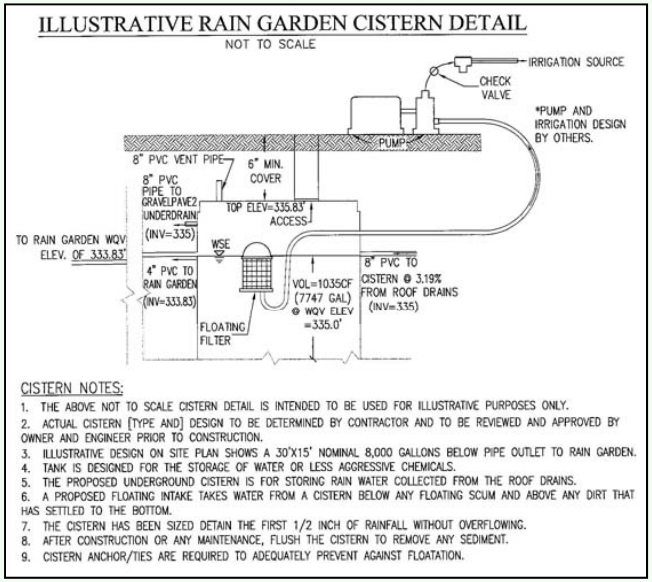
8,000 Gallon Irrigation Cistern

- Collects the “first flush” of roof runoff (1/2” from ½ of the roof)
- Provides irrigation water
- Overflows to rain garden and gravel bed detention
- Cost: $3.88/gal installed

  $1.23/ sf impervious area treated

  (Cistern material only cost: $2.88/gal)



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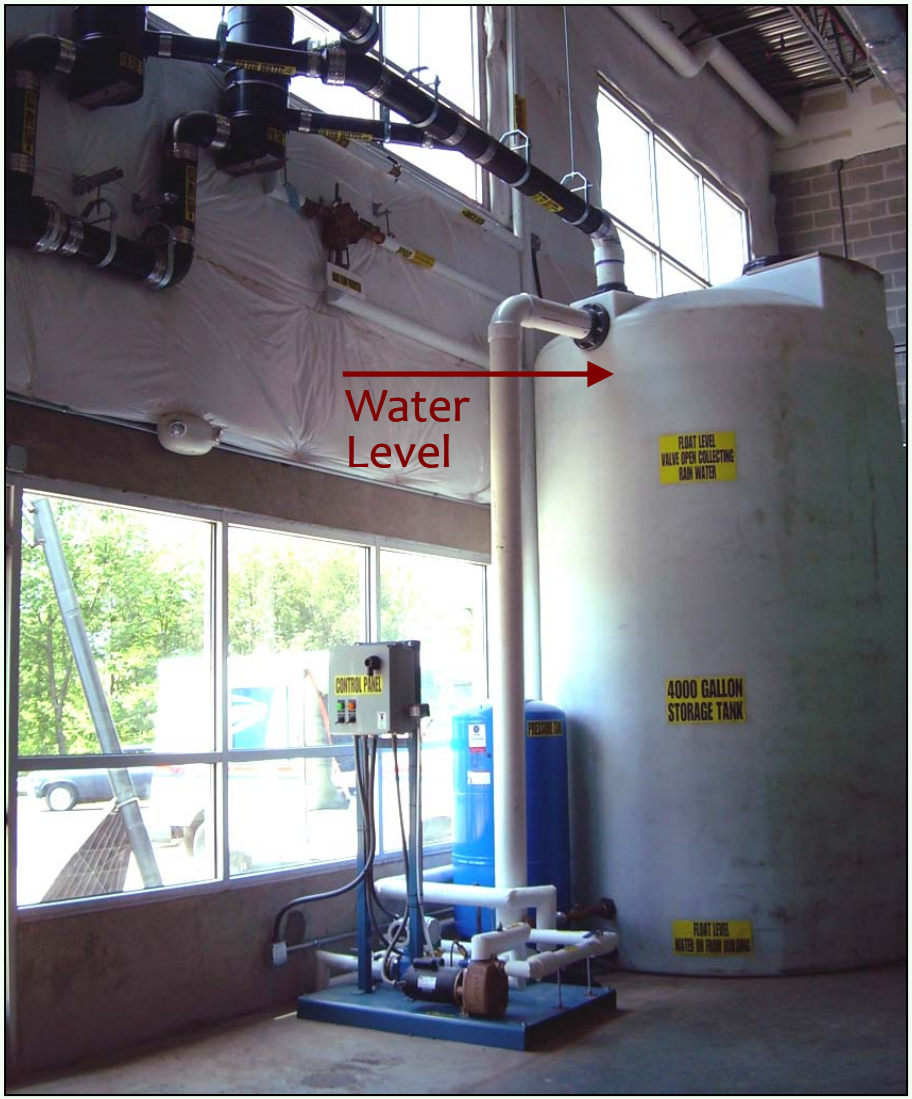
4,000 Gallon Toilet Cistern

- Collects runoff from 3 of the roof's 5 downspouts
- Collects the "first flush" of roof runoff (0.5" or approximately 4,000 gal.)
- Cost: $26.18/gal installed
  (Cistern: $4,430)
  (Pump/filters/valves/pipes: $45,425)
  (Labor: $48,378)
  (Design: $8,620)
  (Permit: $660)
- $7.85/ sf impervious area treated
- Cost would have been substantially lower if the system had been installed during initial construction.
- Overflows to underground cistern



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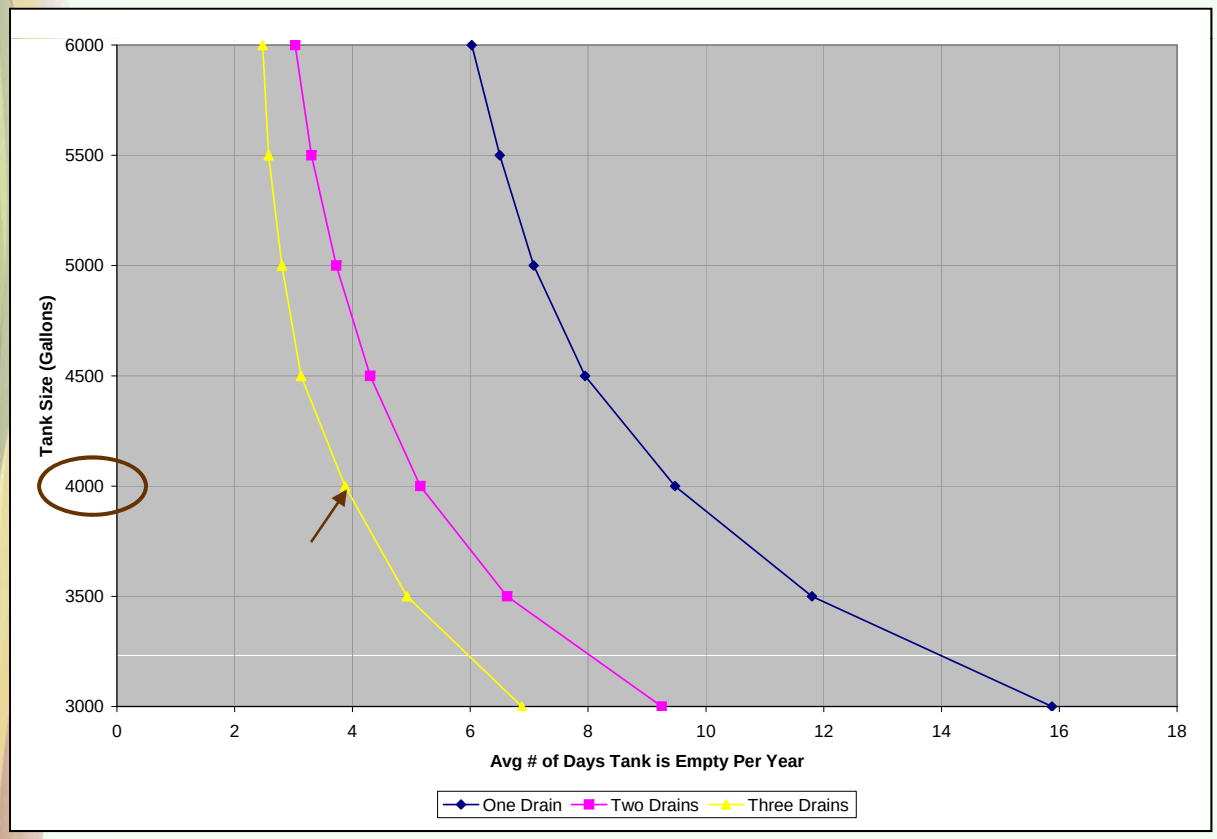
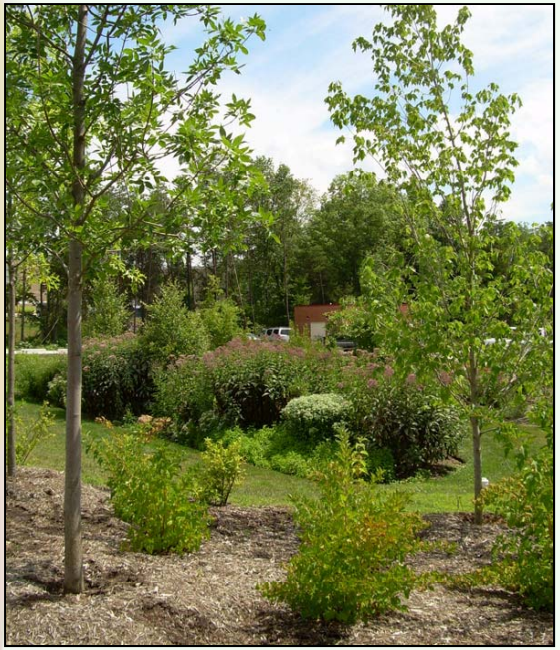
4,000 Gallon Toilet Cistern

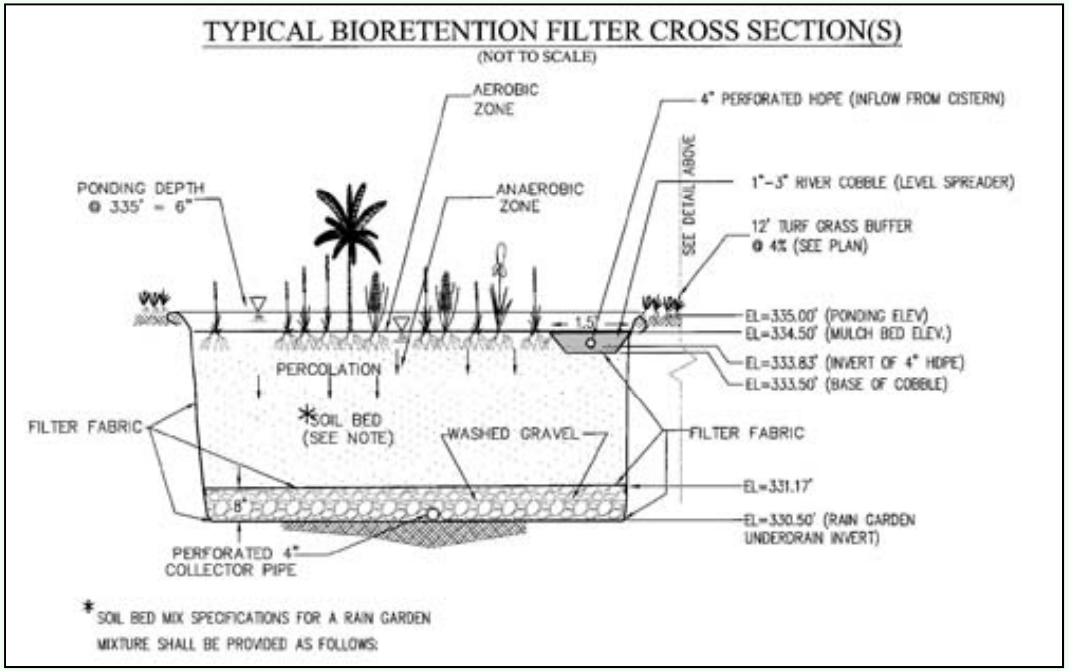
- Design assumptions:
  - 75-people; 2 flushes per person, per day; 1.1 gal. per flush
  - Historic rain data from 1964-2006
- Calculated results:
  - Cistern will be empty approximately 4 days per year
  - Cistern did not go dry during 2009



The Rain Garden



- Treats 34,660 sf of impervious roof and parking lot area
- 1,536 sf bed; 11,693 sf grassed buffer
- Drains to gravel bed detention
- Cost: $2.60 /sf impervious area treated



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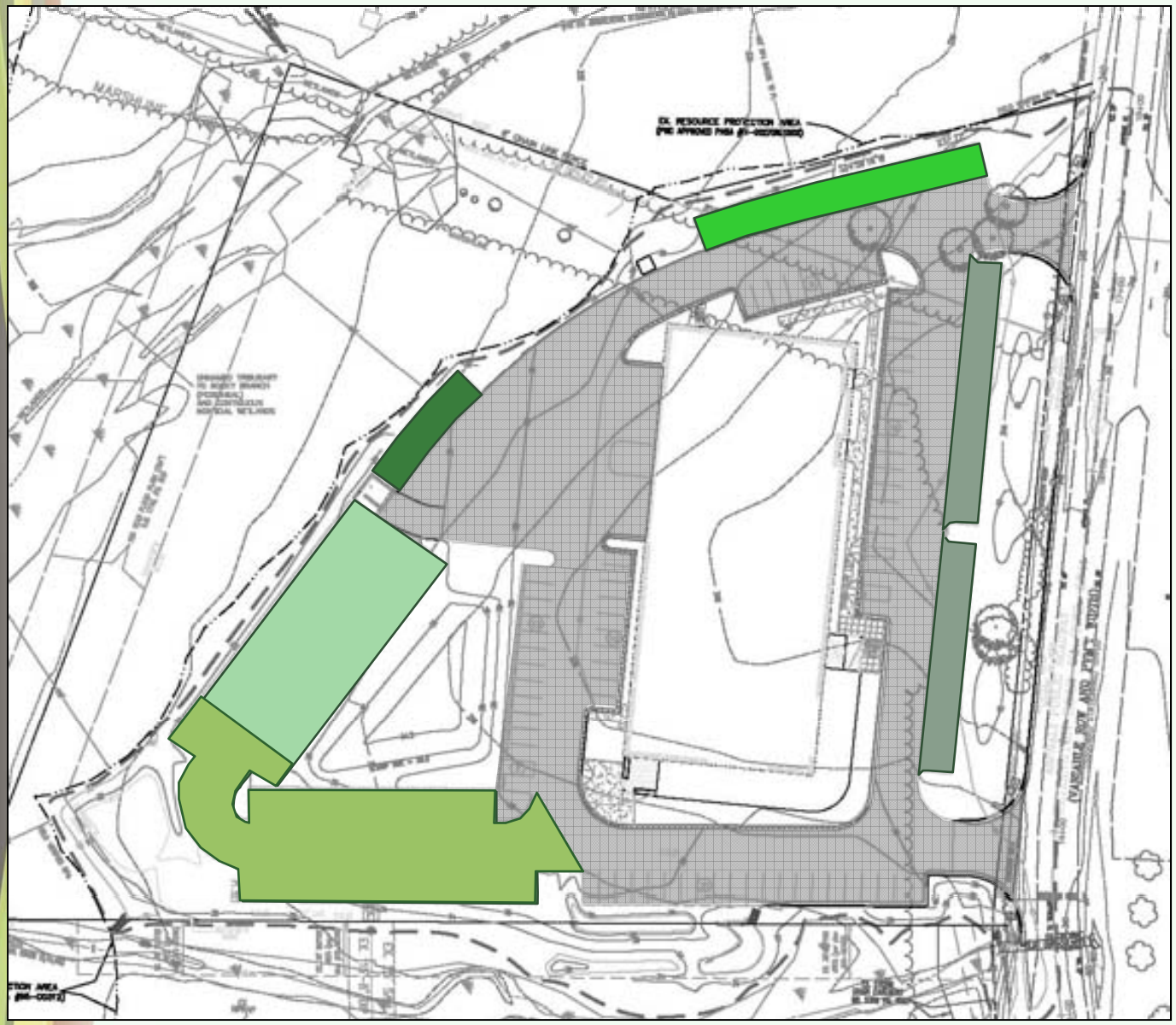
Pervious Parking



Pervious Concrete
11,800 sf

Porous Asphalt
8,120 sf

Gravel Paving
1,275 sf

GravelPave2
3,280 sf

Concrete Pavers
5,502 sf

Asphalt
55,896 sf

Pervious Concrete

- Reduce impervious area by 11,800 sf. (13.7% of total parking area)
- Drains to gravel bed detention
- Approximate cost: $6.00/sf installed
  (Asphalt cost (2005): $2.56/sf)

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Porous Asphalt

- Reduce impervious area by 8,120 sf. (9.4% of total parking area)
- Drains to gravel bed detention
- Approximate cost (2010): $6.73/sf installed
  (Asphalt cost (2005): $2.56/sf)

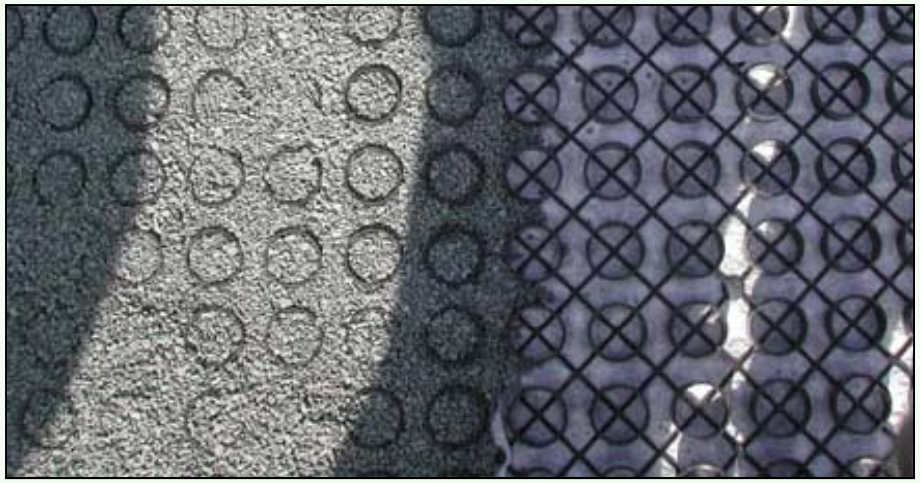
GravelPave2 and Gravel Parking

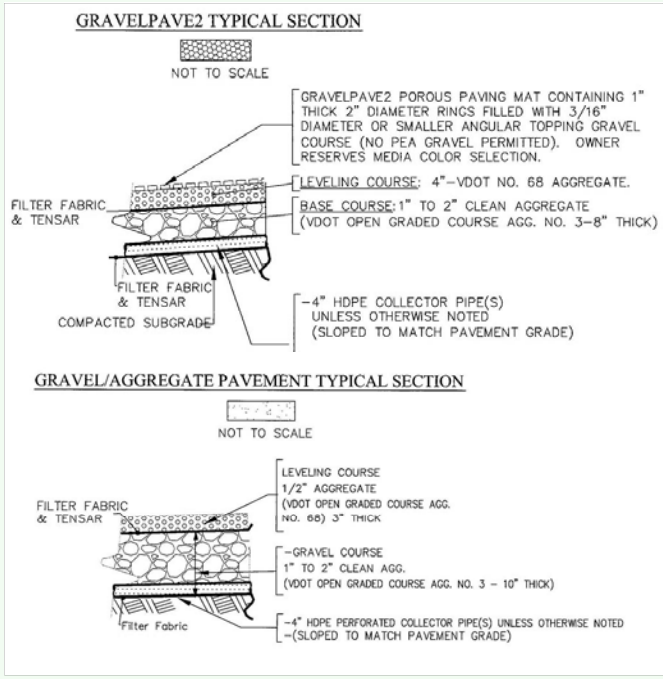
- Reduce impervious area by 4,555 sf (5.3% of total parking area)
- Drains to gravel bed detention or existing vegetated floodplain
- GravelPave2 cost: $6.00/sf installed

  Gravel paving cost: $4.32/sf installed

  (Asphalt cost (2005): $2.56/sf)

  (GravelPave2 materials only cost: $3.20/sf)



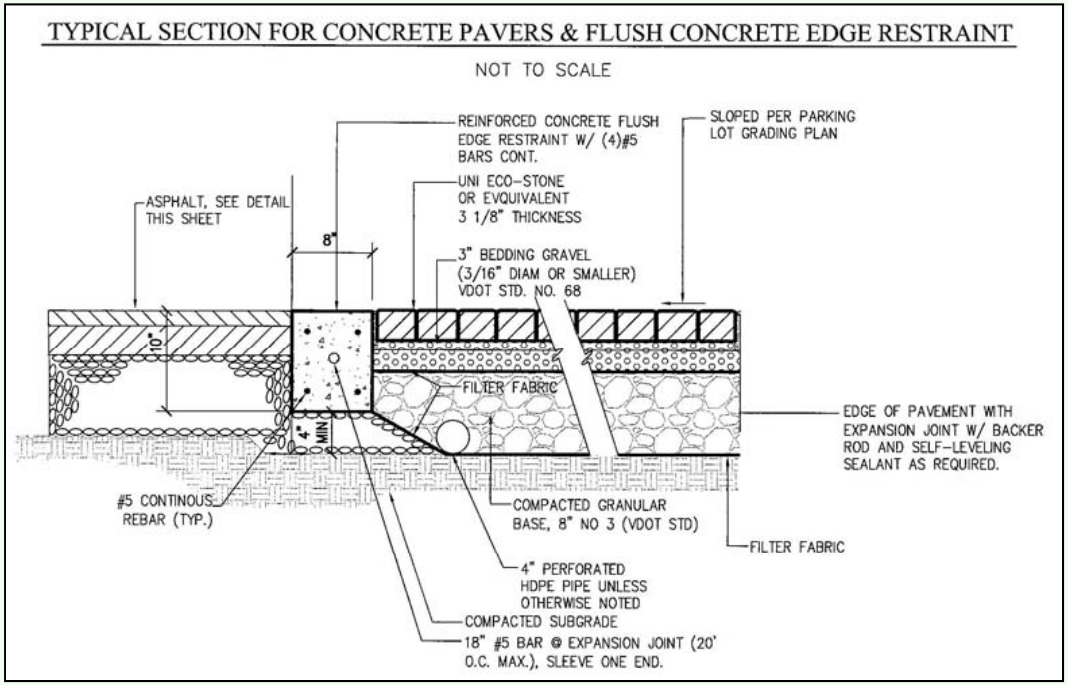


Concrete Pavers

- Reduce impervious area by 5,502 sf. (6.4% of total parking area)
- Drains to existing vegetated floodplain
- Cost: $7.10/sf installed + $0.80/sf header curb

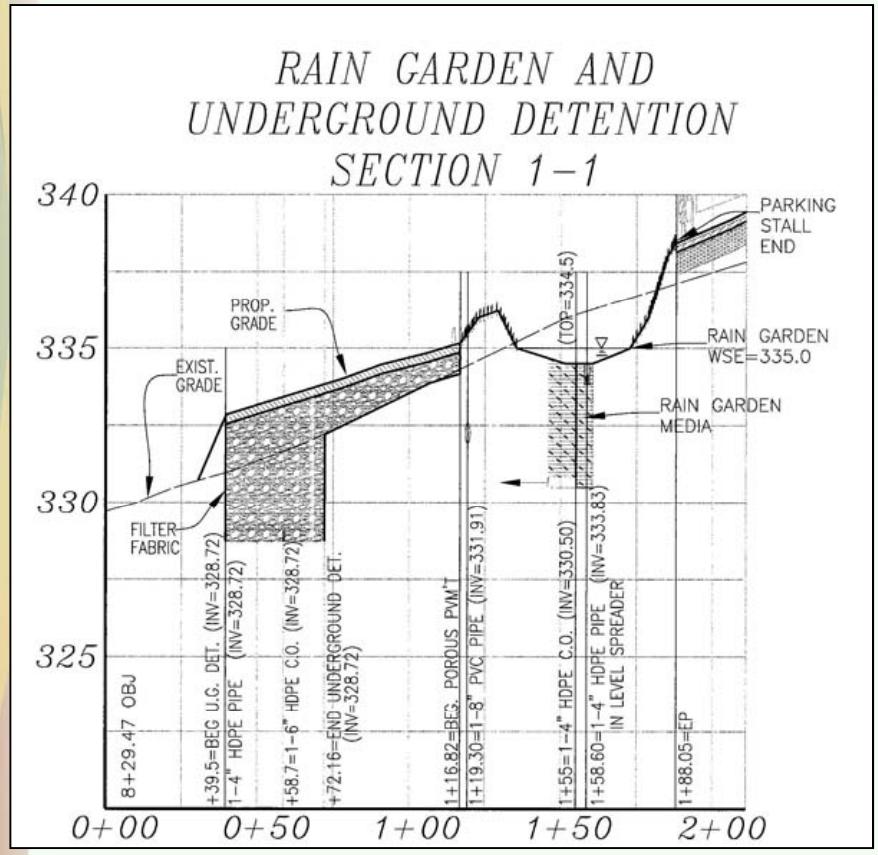
  (Asphalt cost (2005): $2.56/sf)

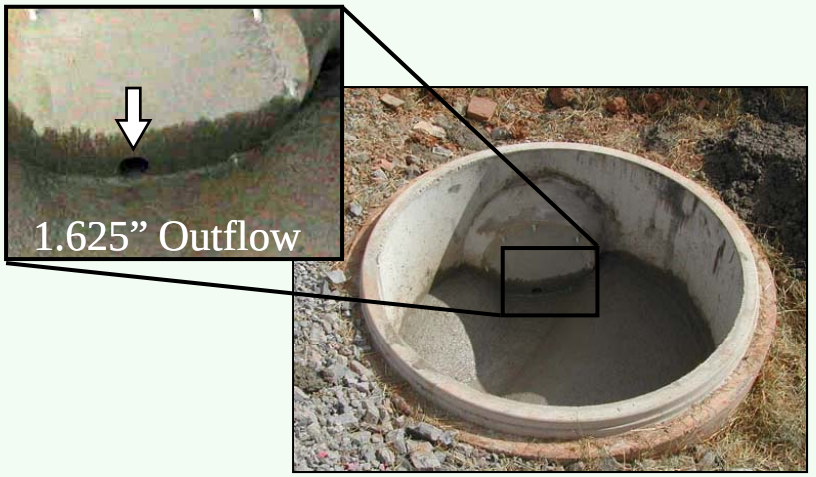
  (Paver material only cost: $2.55/sf)



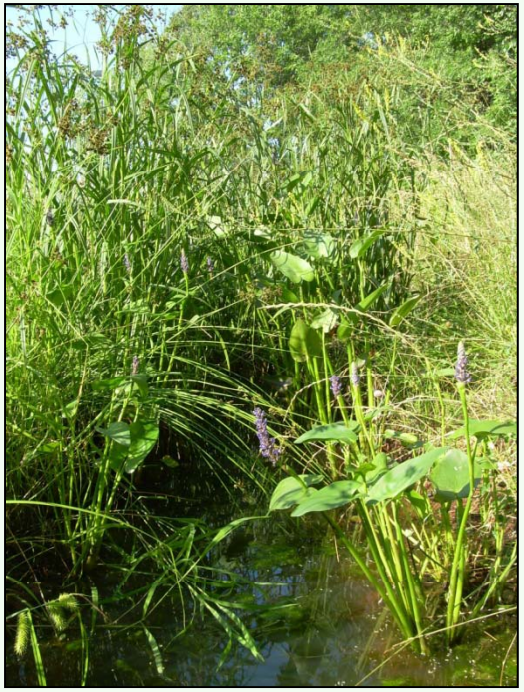
Gravel Bed Detention

- Orifice controlled- drains to existing stream
- Detains the 1-yr storm over 24 hours.
- Cost: $2.28/cf treatment volume installed
  $0.32/sf impervious area treated

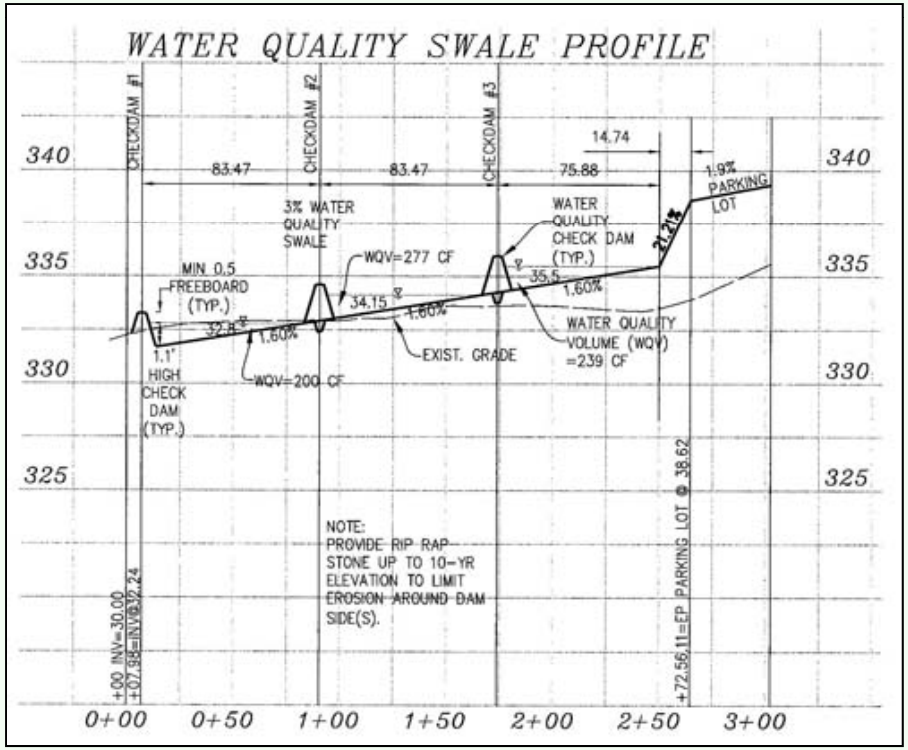




Water Quality Swale



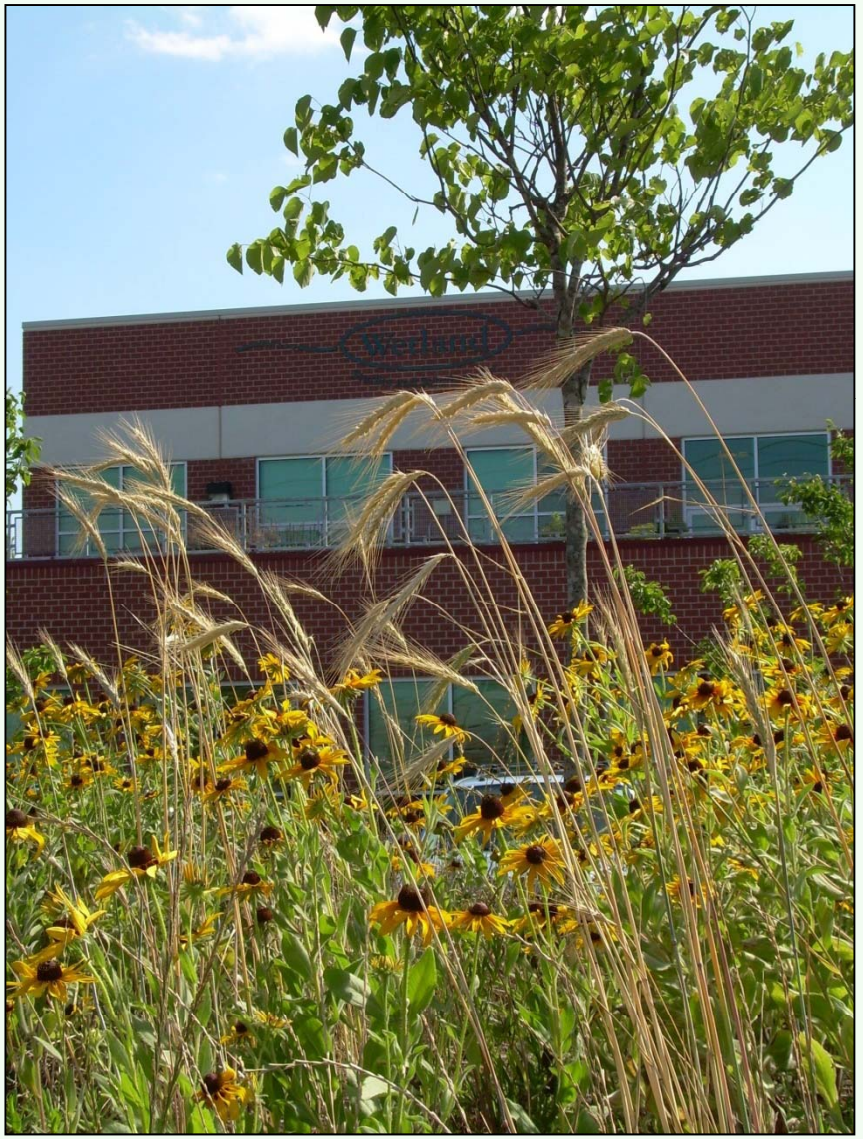
- Collects runoff from 12,650 sf of impervious parking surfaces
- Slows runoff
- Water quality volume filters through check dams
- Cost: $3.68/sf impervious area treated



Naturalistic Landscaping

- Maintains habitat
- Decreases water consumption
- Uses a drip irrigation system and captured rainwater
- Landscape and drip irrigation cost: $125,864

  (Typical landscape and irrigation cost: $80,000)



Modeled Site Performance

Total Phosphorus (TP) Load Reduction:

Pre-developed, forested TP load (based on the VRRM*)	0.11 lb/ac/yr
Post-development TP load without SWM (based on the VRRM*)	0.88 lb/ac/yr
Post-development TP load (based on the VRRM*)	**0.08 lb/ac/yr**

* Draft Virginia Runoff Reduction Method worksheet dated December 7, 2009 (This worksheet excludes the TP load from forests.)

Volume Reduction:

Pre-developed, forested runoff volume (based on 1" rainfall)	922 cf
Post-development runoff volume without SWM (based on 1" rainfall)	7,625 cf
Post-development volume (based on 1" rainfall)	**1,607 cf**

Peak Runoff Reduction:

Pre-development runoff rate (based on 1.5-year storm)	9.42 cfs
Post-development runoff rate (based on 1.5-year storm)	**7.94 cfs**

Actual Site Performance

Peak Runoff Rate Reduction:

Conventional site peak runoff rate (1.1” rainfall)	5.65 cfs
Pre-developed, forested runoff rate (1.1” rainfall)	0.36 cfs
Post-development runoff rate (1.1” rainfall)	**0.05 cfs**

Volume Reduction:

Total rainfall	7,900 cf
Conventional site volume	7,300 cf
Pre-developed, forested volume (modeled)	400 cf **
Post-development volume (measured)	**2,300 cf**

* Petrey, S., “Low Impact Development (LID) Case Study: Wetland Studies and Solutions, Inc. Headquarters, Gainesville, Virginia.” 2007

** The forested volume on this and the preceding slide do not agree because of modeling differences between the VRRM and TR-55

Energy Balance*: $Q_{developed} \leq I.F. \times Q_{pre\text{-}developed} \times RV_{pre\text{-}developed} / Rv_{developed}$

$\leq 0.8 \times 0.36 \text{ cfs} \times 400 \text{ cf} / 2{,}300 \text{ cf}$

$\leq 0.05 \text{ cfs}$

*Note that the 1.1” event is NOT equivalent to the 1-year, 24-hour storm. This example only shows the Energy Balance theory.

Site Cost Analysis

Item	$/sf impervious	Cost
Rain garden	$2.60	$90,000
Irrigation cistern (8,000-gal.)	$1.23	$31,000
Toilet cistern (4,000-gal.)	$7.85	$109,940
Green roof	$31.80	$115,316
Pervious concrete pavers	$7.90	$39,000
Gravel pavement	$4.32	$5,500
GravelPave2 system	$6.00	$143,500
Pervious concrete	$6.00	N/A
Porous Asphalt	$6.73	N/A
Gravel bed detention	$0.32	$24,000
Swale	$3.68	$46,525
Native landscaping and drip irrigation	N/A	$125,864
	Total	**$730,645**
Standard asphalt / curb-and-gutter estimate		$360,115

How Did WSSI Achieve LEED Gold?

What is LEED?

- LEED stands for “Leadership in Energy and Environmental Design”
- LEED is a voluntary certification system created by the U.S. Green Building Council.
- The system is consensus-based, meaning that all aspects of the building industry have a voice in the criteria.
- The system has four levels of certification –
  - *Certified* for achieving 40-50% of the possible credits;
  - *Silver* for achieving 50-60% of the possible credits;
  - *Gold* for achieving 60-80% of the possible credits; and
  - *Platinum* for achieving more than 80% of the possible credits.
- WSSI’s facility is certified *Gold.*
- WSSI’s facility was the eighth LEED-Certified project in Virginia and the first to rise above the *Silver* rating, as of March 2, 2006.

Why Did WSSI Become LEED Certified?

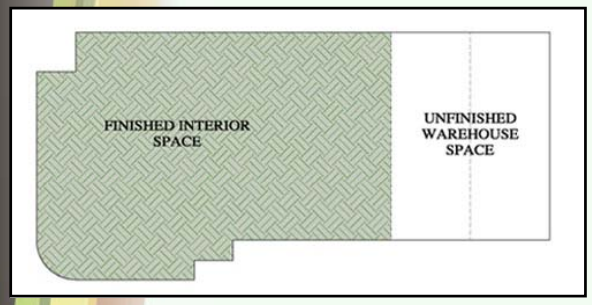
- To determine what is involved with building and certifying an environmentally-advanced (“green”) building
- To tangibly validate the achievement of creating a green building
- But… Why create a green building in the first place?
  - Because green buildings are efficient and economical to operate
  - Because green buildings are healthy to work in
  - Because green buildings are healthy for the environment without sacrificing human comfort or needs.
  - Because it’s the right thing to do.

What Types of Projects Does LEED Certify?

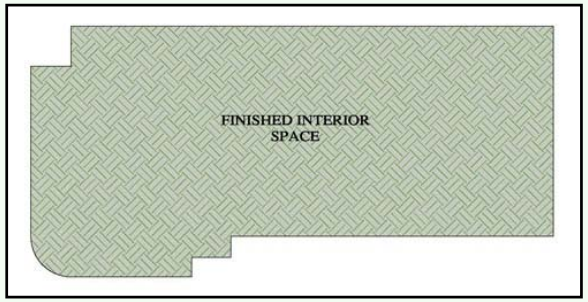
- LEED covers different types of projects through different rating systems:
  - LEED-NC is for new construction
  - LEED-CI is for commercial interiors
  - LEED-EB is for existing buildings
  - LEED-CS is for core and shell buildings
  - LEED-H is for residential homes
  - LEED-ND is for new development
- WSSI's building is certified under the LEED-CI rating system. Why?

Why Did WSSI Certify Under LEED-CI?

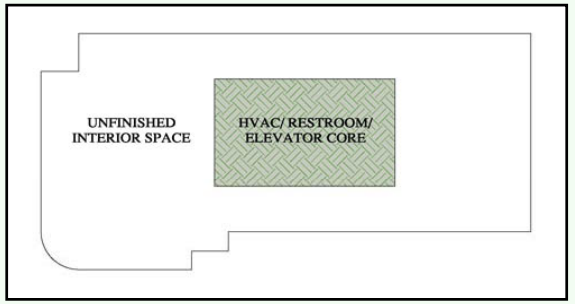
- Why not certify under:
  - **LEED-NC**? Even though WSSI built the entire building, so it is "new construction," only a portion of the interior is finished for occupancy. The rest is unfinished shell space (without plumbing, HVAC, or electrical systems) which LEED has no mechanism to certify. This would have made certifying the entire building nearly impossible.
  - **LEED-CS**? Our base building is a typical speculative office/warehouse design that only provides a "cold, dark shell." No elevator/HVAC/restroom core is included in the base building plan, which is the type of product the CS rating system was created to certify.
- Why certify under **LEED-CI**?
  - WSSI chose to certify under the Commercial Interiors rating system because it most fits our project scope and properly reflects the depth of innovation that went into the finished portion of the building.



The WSSI building layout



A typical NC building layout



A typical CS building layout

What Are the LEED-CI Categories?

- **Category 1 – Sustainable Sites**
  Focuses on site selection and design

- **Category 2 – Water Efficiency**
  Focuses on reducing potable water needs

- **Category 3 – Energy and Atmosphere**
  Focuses on HVAC, lighting, and appliance efficiency and controllability

- **Category 4 – Materials and Resources**
  Focuses on building with recycled, rapidly renewable, and regional materials, as well as waste recycling and reuse

- **Category 5 – Indoor Environmental Quality**
  Focuses on human comfort, daylighting, and the use of low-emitting building materials

- **Category 6 – Innovation and Design Process**
  Gives credit for items not specifically covered in the rating system

Sustainable Sites and Water Efficiency

- Heat island and light pollution reduction
- Low-impact development
- Native landscaping and water-efficient irrigation
- Bicycle storage and changing rooms

- Low-flow sinks, toilets, and showers
- Motion-based faucet controls
- Waterless urinals
- 72% reduction in potable water use

Energy and Atmosphere

- Daylight- and motion-responsive lighting
- Light density of 0.9 Watts/square foot
- Energy Star appliances
- Green power credits for 100% of electricity used
- 35% lower energy usage than a typical building of WSSI's size
- No CFC's used in HVAC or refrigeration


CERTIFICATE
OF ENVIRONMENTAL STEWARDSHIP
STERLING PLANET
PROUDLY PROVIDES
2,000,000 KILOWATT HOURS
100% RENEWABLE ENERGY
TO
WETLAND STUDIES BUILDING
GAINESVILLE, VIRGINIA
AUGUST 31, 2005
SPI-2005-08 13000

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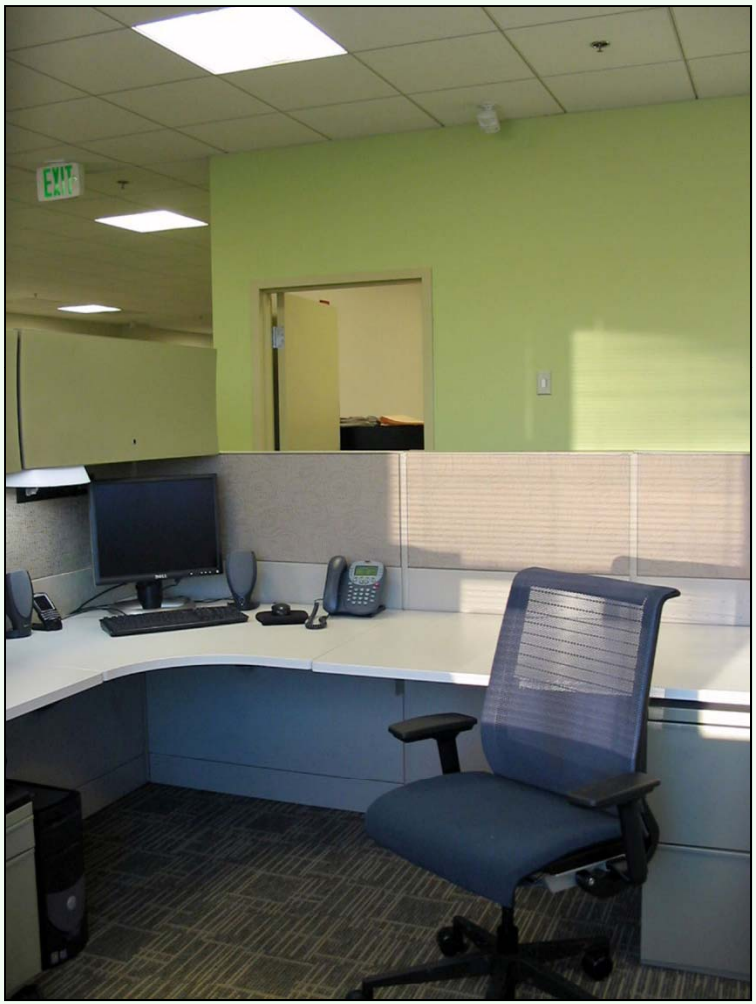
Materials, Resources, and Indoor Air Quality

- 26% recycled content throughout building
- 35% regional materials throughout building
- 11% rapidly-renewable materials throughout building
- Low-VOC paints, coatings, carpeting, and furniture
- 62 thermal zones
- Access to direct daylight and views
- Carbon dioxide sensors to deliver fresh air
- 3 times more ventilation than required by code



Innovation and Design Process

- WSSI uses the building as a laboratory for the study of LID practices
  - Staff frequently provide building and site tours
  - Seminars are held for various organizations (regulatory officials, builders, etc.)
  - Staff create case studies and brochures to promote “green” design

LEED Features at WSSI

THE REST ROOMS

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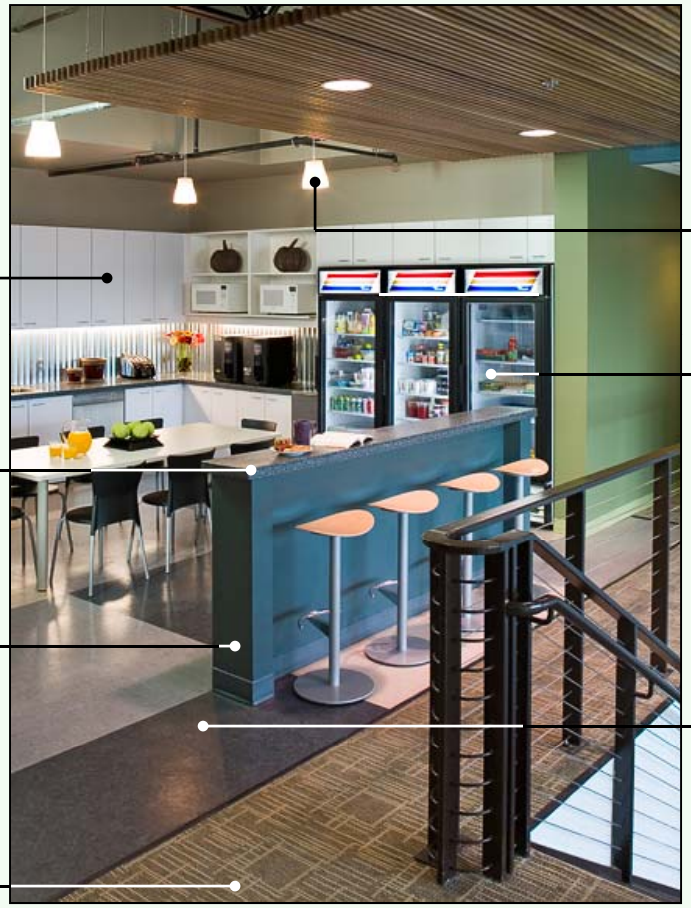
LEED Features at WSSI



Rapidly-renewable, 95% recycled wheatboard cabinets

Compact fluorescent lights

High-efficiency appliances

35% recycled content in metal-shaving countertop

Rapidly renewable linoleum flooring (made with linseed oil and wood flour/cork dust)

Low-VOC paint

11% recycled content in carpeting

THE KITCHEN

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LEED Features at WSSI

THE CONFERENCE ROOMS

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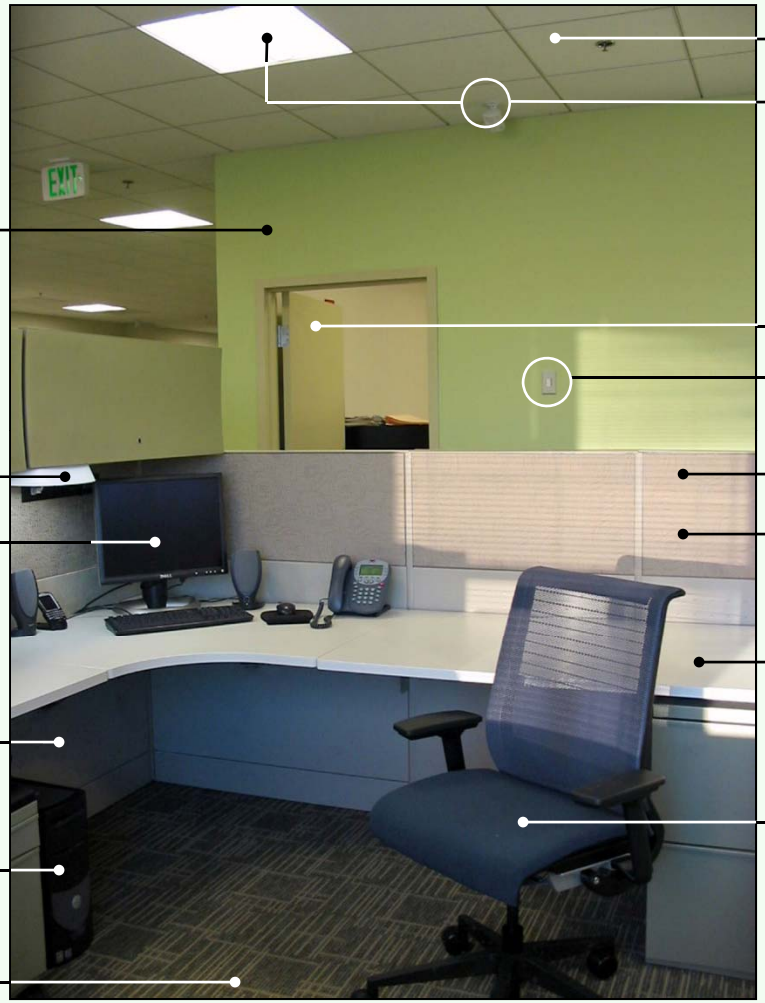
LEED Features at WSSI



78% recycled content in ceiling tile

Motion-controlled lights

Low-VOC paints

50% recycled content in doors and frames

62 thermal zones

Task-level lighting

Daylighting

EnergyStar monitors

Corn-based PLA fabric

Rapidly-renewable, 95% recycled wheatboard

30% recycled steel in workstation panels

45% recycled content in task chair

EnergyStar computers

11% recycled carpet and low-VOC adhesive

THE WORKSTATION

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What is the Cost Breakdown?

Hard Cost	Credits	Premium	$ / Credit
Sustainable Sites	4	$312,080	$78,020
Water Efficiency	3	$6,100	$2,033
Energy and Atmosphere	8	$92,085	$11,511
Materials and Resources	6	$43,895	$7,135
Indoor Environmental Quality	11	$127,750	$11,614
Innovation and Design Process	2	$3,250	$1,625
“Hard Costs” Subtotal	34	$585,160	$17,210
Total Building Cost	$5,696,100 – (10.3% Premium)		
Soft Cost			
Documentation, Paperwork, and Consulting Fees	34	$111,900	$3,290
Total Non-LEED Design Cost (Civil = $141,754; Architecture = $96,544; Interior Design = $134,663)	$372,960 – (30.0% Premium)		
Total LEED Premium (Hard Cost + Soft Cost)	34	**$697,060**	$20,050

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What About Utility Savings?

Utility Type	Annual Use	Rate / Total Cost	Savings
Irrigation water		**$2.90 / 1,000 gal** [1]	$7,540 / year
Estimated typical use	2,600,000 gal	$7,540	
Estimated WSSI use	200,000 gal	$0	
Total premium for cistern, drip irrigation, and native landscape			$45,864
Capitalized value of savings (at 6%)			$125,667
Payback			**6.1 years**
Potable water (with toilet cistern)		**$8.45 / 1,000 gal** [1]	$1,497 / year
Estimated typical use	245,214 gal	$2,072	
Estimated WSSI use	68,084 gal	$575	
Total premium for low-flow and waterless fixtures, cistern, and pump equipment (excl. installation)			$55,954
Capitalized value of savings (at 6%)			$24,950
Payback (with toilet cistern)			**37 years**
Potable water (without toilet cistern)		**$8.45 / 1,000 gal** [1]	$1,049
Estimated typical use	245,214	$2, 072	
Estimated WSSI use (before cistern)	121,095	$1,023	
Total premium for flow-flow and waterless fixtures (excl. installation)			$6,100
Capitalized value of savings (at 6%)			$17,483
Payback (without toilet cistern)			**5.8 years**

1. Water costs per PWC Service Authority, 9/1/08-9/1/09

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What About Utility Savings?

Utility Type	Annual Use	Rate / Total Cost	Savings
Electricity		$0.13 / kWh[1]	$50,291 / year
Typical Estimated Annual Electric Use	968,100 kWh	$125,853	
WSSI Annual Electric Use	581,243 kWh	$75,562	
Gas		$1.30 / therm	$17,703 / year
Typical Estimated Annual Gas Use	15,600 therms	$20,280	
WSSI Annual Gas Use	1982 therms	$2,577	
Total Energy Savings			$67,994 / year
Total Cost of LEED-Related Items (Green power certificate, metering equipment, reflective roof, HVAC equipment, operable windows, lighting equipment, insulation, Energy Star appliances, and task lighting)			$114,735
Capitalized Value of Savings			$1,133,240
Payback			1.7 years

1. Estimated energy cost per NOVEC 3R LP (for large power service)

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What Else Has WSSI Done?

Employee Health and Happiness

- Gym for employee use
- Trainer-led workouts five times per week
- Cardio and weight machines and volleyball net
- Weight Watchers weekly meetings
- 6-room kennel and outdoor dog run for employee dog care
- Community garden
- Boardwalk and Nature Trail

Additional Green Upgrades

- Solar hot water
- Full-spectrum fluorescent lighting
- Living wall
- Dog waste composter
- Solar electricity (possible future project)

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Thanks to the WSSI Project Team

- **User** – Wetland Studies and Solutions, Inc.
- **Project Management** – The Peterson Companies
- **LID Concept Plan** – Wetland Studies and Solutions, Inc.
- **Civil Engineering** – Urban Engineering and Associates, Inc.
- **Architecture** – W.A. Brown & Associates, P.C.
- **Mechanical, Electrical, Plumbing** – Potomac Energy Group, Inc.
- **Interior Design** – Bartzen + Ball
- **Building Commissioning** – Advanced Building Performance, Inc.
- **General Contracting** – EEReed Construction, LP
- **Site Work** – S.W. Rodgers
- **Green Roof Installation** – The Furbish Company
- **Pervious Concrete** – Virginia Ready-Mixed Concrete Association
- **Toilet Cistern Design** – E.K. Fox & Associates, Ltd.
- **Photos** – Ron O. Blunt Photography

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Questions?

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