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Retrofitting LID Practices Into Existing Neighborhoods: Is It Worth It?

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Why Consider Retrofitting?

- Impervious surfaces can generate large volumes of runoff (Ando and Freitas 2011)
- Urban runoff can contain many pollutants (Makepeace et al. 1995).
- Combined sewers overflow carrying a mix of sewage and stormwater into surface water bodies (USEPA 2004).
- LID practices focus on reducing runoff volumes through on site storage, treatment, and infiltration (USEPA 2007).
- LID practices may provide cost savings from fewer pipes, drains, and smaller treatment plants (Gunderson et al. 2011).

Figure 1: EPA Diagram Illustrating Urban Water Systems

Low Impact Development (LID) Practices:

- Rain Barrels
- Cisterns
- Bioretention
- Pervious Pavements
- Green Roofs

Methods:

- Select several areas around Greater Lafayette
- Use ArcMap and available datasets to classify land use
- Use assumptions made by the L-THIA LID model to determine the types of land cover in each use
- Apply selected LID practices at adoption rates between 10 and 100%
- Determine cost range for the implementation
- Estimate average annual runoff reduction
- Estimate average amount of money saved by reducing runoff
- Estimate time period for payback based on savings from reduced runoff

Study Area:

Figure 2: Aerial Photograph of Historic Neighborhood Study Area

Long-Term Hydrologic Impact Assessment (L-THIA) Model:

Uses:

- 30 years of daily rainfall data
- Land use and soil hydrologic group data
- SCS Curve Number method
- Yearly simulation

Outputs:

- Average annual and annual runoff volume
- Average annual and annual pollutant loads

Figure 3: Approximate breakdown of land uses in the Historic Neighborhood

Figure 4: L-THIA LID interface

Cost of Implementation:

Table 1: Cost Ranges for LID Methods
(CNT 2009; SEMCOG 2008)

Practice	Price Range		Cost Unit
	Low	High	
Rain Barrel	\$ 100.00	\$ 380.00	per Barrel
Cistern	\$ 0.19	\$ 1.79	Per Liter of storage
Bio-swale	\$ 37.46	\$ 512.58	Per Square Meter
Porous Pavement	\$ 15.93	\$ 129.17	Per Square Meter
Green Roof	\$ 45.75	\$ 261.02	Per Square Meter

- For permeable pavement and green roofs, multiply area cost per area
- For bio-swales, multiply the cost per area by 15% of treatment area
- For rain barrels and cisterns, use initial abstraction curve number to determine storage volume and multiply storage volume by cost per volume.

Savings from LID Practices:

Table 2: Estimated costs for water

Cost of Water		
Type	Price	Unit
Drinking water	\$ 0.57	Cubic Meter
Waste water treatment	\$ 1.32	Cubic Meter

- These values were determined based on the city of Lafayette, Indiana's user fees for drinking water and sewer.
- These values are multiplied by reduction in runoff to estimate potential average annual savings.
- The value for drinking water is only applied to rain barrels and cisterns.

Results:

Figure 5: Total percent reduction of runoff based on percent of adoption of LID Practices evenly throughout the study area

Is It Worth It?

- Runoff can significantly be reduced by adopting LID practices, even at low to moderate adoption rates
- Retrofitting LID practices can save money by conserving drinking water and decreasing volume of waste water treated
- These savings can in some cases pay off cost of installation plus interest
- However, in other cases amount of interest can exceed savings
- Awareness early in planning process can help set realistic goals and control costs

Further Research Ideas:

- Analysis of other factors that may impact economic value like aesthetic appeal, improved environmental quality, energy savings, and maintenance requirements.
- Impacts of design decisions on performance and economics of LID practices

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Table 3: Estimated time to payback in years

Estimated Payback Period at 4.46% APR Based on Water Savings							
Landuse Type	Cistern Size	Cost	Rain Barrel	Cistern	Bioretention	Permeable Pavement	Green Roof
2 Ac Lots	N/A	Low	3.06	n/a	No	No	n/a
	N/A	High	14.92	n/a	No	No	n/a
1 Ac Lots	N/A	Low	3.47	n/a	No	20.42	n/a
	N/A	High	17.62	n/a	No	n/a	n/a
1/2 Ac Lots	N/A	Low	2.91	n/a	No	22.72	n/a
	N/A	High	13.86	n/a	No	No	n/a
1/3 Ac Lots	N/A	Low	2.91	n/a	No	27.11	n/a
	N/A	High	13.83	n/a	No	32.60	n/a
1/4 Ac Lots	N/A	Low	2.34	n/a	No	No	n/a
	N/A	High	10.53	n/a	No	No	n/a
1/8 Ac Lots	N/A	Low	2.13	n/a	No	No	n/a
	N/A	High	9.41	n/a	No	No	n/a
Commercial	Small	Low	1.54	17.46	No	No	No
	Med	High	21.62	9.39	No	No	No
Industrial	Small	Low	n/a	1.88	21.89	No	No
	Med	High	n/a	31.06	5.28	No	No
Opens Space	Small	Low	n/a	12.14	No	No	No
	Large	High	n/a	No	No	No	No

Note: 4.46% APR based on the 1 month average for a 30 year fixed rate loan as shown by Bloomberg.com (<http://www.bloomberg.com/markets/rates-bonds/consumer-interest-rates/>) on Oct. 2, 2013