



Integration of Land Suitability Analysis and Low Impact Development Design: 土地适宜性分析和低影响开发设计的整合

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The "ills" of development!

- Urban developments often lead to城市化致使
 - Large impervious surfaces 大面积不透水表面
- Urban areas have
 - Greater volumes of runoff and 大量地表径流
 - Higher peak discharge 高洪峰流量
 - Residential subdivision designs aggravate the impacts of urbanization by 居民小区设计
 - Provision of large parcel lots
 - Paved driveways wider and more prevalent road networks 大量宽阔的车道







High costs

- Over \$25 billions have been spent (by Army Corps of Engineers on flood control projects)
- Still, the annual loss due to floods over \$4 billion
- Painful reality is that the solutions in the past have resulted in no or little results
 - Local solutions and new alternatives are needed to tackle this scenario
- 损失惨重(\$40亿/年),巨额开销,效果甚微
- 需要另辟途径





- An alternate design solution for residential development that is sensitive to potential environmental impacts
- Explore the feasibility and benefit of "Land Suitability Analysis" and "Low Impact Development" (LID) design
- 土地适宜性分析 + 低影响开发 (LID) 设计



Why this effort?

- Conventional subdivision development does not consider runoff as a prime design aspect
- It discourages sustainability in terms of
 - Health less walking
 - Social less interaction
 - Energy more consumption
 - Environment flooding
 - Economy maintaining
 - Ecology fragmentation
- 传统开发方式不重视径流
- 不鼓励可持续性 卫生,社会,能源,环境,经
 济,生态





- Our approach is shaped by the sustainability mantra
- We hypothesize that a design should be implemented only if it achieves environmental and economic sustenance and promotes a better quality of life
 - 环境和经济的持续性
 - 改善生活质量

Study watershed







 A part of experimental watersheds operated by the United States Department of Agriculture (USDA) – Agricultural Research Service that are used to study the effects of land use upon hydrology and water quality

Conventional subdivision





- An expanded site assessment that integrates data with hydrologic significance into land suitability analysis, and 土壤水文
- A complementary subdivision design based on principles of conservation subdivision design 保护性开发原则



Characteristics of CSD

- Preserve at least 25 to 50% of the site as conservation areas保留1/4至一半土地
 - primary (steep sloped sites, wetlands etc.) and主要: 坡地,湿地
 - secondary (wooded tracts, wildlife habitat, farmlands etc.) 次要: 林地,野生动物栖息地,农田
 - Cluster development on the rest areas 紧凑
- Narrow and short street 窄街
- Density neutral密度不变
- Smaller lots size with larger open space view 小地块大视野



- Reduce the runoff减少径流
- Minimize development "foot print" and alternations to the natural features最小变化
- Reduce air, sound & water pollution减少污染
- Conserve water and energy with appropriate building materials, technology, and climatologically sensitive design 节约水、能
 Minimize facility maintenance最大限度地减少维

Soil type and surface elevation

Legend

2m Contour

Soil Type

material colluvium from sandstone and siltstone

a alluvial deposit

ेत्री residuum and colluvium from sandstone।

silty deposits

residuum and colluvium from fine and medium grained sandstone

- veathered sandstone residuum
- 📲 residuum from sandstone
- residuum from fine and medium grained sandstone

0 20 40 80 120 160 Meters





Slope in %





Suitability factor scores

HSG Category	Value	Slope Category	Value	Drainage Category	Value
A	1	<=6 %	10	Well-drained	10
В	4	7-12 %	7	Moderately drained	6
C	7	13-18%	4	Well drained with localized	7
D	10	19-25%	1	spots of wetter soils	
		>25%	0		



Land suitability analysis

相对重要性



Land suitability

N



0





CSD subdivision







- Three different design scenarios were made to assess the impact of each of the design type.
 - Conventional site planning with regular road widths, housing units and all other "typical" neighborhood ingredients 传统方案
 - LID with "conventional house" footprints and低影响开发(LID)设计-传统建筑面积
 - LID with smaller foot print低影响开发(LID)设计-小 建筑面积



Predicted runoff depth

				Runoff Depth (cm)					
	Recurrence	Rainfa	all						
								LID v	v/
								smalle	er
	Interval				Convent	ion		housir	ng
_	(Year)	Depth (cm)	Natural	al		LID	<u>foot pr</u>	int
	2	6.4		1.1	1.7		1.2	1.3	
	10	8.9		2.4	3.3		2.7	2.8	
	25	10.2		3.2	4.2		3.5	3.7	
	50	11.4	ŀ	4.1	5.2		4.4	4.6	
	100	12.7	1	5.0	6.2		5.4	5.6	
Runoff Depth (% increase from natural)									
Recuri	rence Rain	nfall		•					
							I II	$\mathbf{D}\mathbf{w}/\mathbf{w}$	
I	nterv						sm	aller	
	al			Con	vention		hou	sing	
C	Year) Depth	n (cm)	Natura	1	al	LID	foot	print	
	2	6.35	n/a	5	55%	26%	17	7%	
	10	8.89	n/a	3	37%	18%	12	2%	
	$\overline{25}$	10.16	n/a		81%	15%	9	%	
	$\frac{1}{50}$	11.43	n/a		28%	14%	9	%	
	100	12.7	n/a		25%	12%	8	%	
							_		



As compared to natural conditions

- Conventional development increased runoff depth for a 2-yr storm by 55 percent.
- For LID approach, runoff depth increased by 26 and 17 percent, for the same and smaller building size respectively.

Which is a significant achievement



Economic benefits

Developer benefits: lower cost								
	Conventional	LID	Cost of Saving	Cost of saving (%)				
Site preparation	\$126,875	\$49 <i>,</i> 028	\$77 <i>,</i> 847	61%				
Road installation	\$40,000	\$14,400	\$25 <i>,</i> 600	64%				
Stormwater management	\$42,562	\$19,125	\$23,437	55%				
Landscaping	\$174,850	\$124,300	\$50,550	29%				
Total	\$384,287	\$206,853	\$177,434	46%				

Marketing benefits: higher house price

Resident\homebuyer benefits: Cost saving of landscaping maintenance: \$3,395

建设和维护费用低,房值高



Quality of life benefits

Resident\homebuyer benefits

 5 acres more natural open space
 Recreation opportunities
 Community activities & social interaction

活动空间大,户外娱乐交流方便



Conclusions

- People are skeptical toward unfamiliar alternatives, especially when the benefits are not firmly established
- Developers are skeptical about the costs and the impacts of the development on the prospective buyers
- The benefits that an LID economically, ecologically and psychologically is often ignored

人们可能持怀疑态度 LID的经济生态和心理优势常被忽略



Is LID technically viable? Use resources wisely? Better livable environment? 技术可行? 善用资源? 优质生活?







Lets remove the apprehension and get ahead...

打消顾虑



Thank You