Cost Savings in Ecologically Designed Conservation Developments

By

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Abstract

There is an interest in the real-estate development world to quantify costs of different development techniques. This paper presents a standardized method to compare residential development designs using conservation and conventional design approaches. Residential development projects are designed using two different design methodologies on the same parcels, using unit costs provided by the developers and Applied Ecological Services (AES) for land restoration and management, then the results are compared side by side. Ten representative projects from the Midwestern USA are used to evaluate and demonstrate the value of conservation design in a standard comparison methodology and format. These comparisons document a total development and average per-lot savings of 10% and 25%, respectively, using the ten representative projects. Individual project comparisons ranged from 13% more spent with conservation development, to 34% saved. The minimum average per-lot savings ranged from a low of 5% to a high of 39%.

Savings were found in reduced infrastructure (e.g. roads lengths, widths and nested utilities – sanitary, water, electrical), reduced or eliminated site changes (e.g. earthmoving) and infrastructure (e.g. stormwater sewers, detention ponds, etc), and creation of land-use features that are less expensive to create and maintain (e.g. native landscaping instead of formal landscapes). This standardized cost-comparison approach can be used by other developers, designers, and citizens to evaluate community choices in future development proposals.

Introduction

Clarifying the "bottom line" associated with alternative approaches to land developed has been difficult because of the proprietary nature of project economics. Yet at the same time, market transformation can occur best and most expeditiously if investors clearly understand the benefits of their investments. The market doesn't change unless investors openly see increased value, reduced time to obtain returns, or other benefits including non-monetary values (e.g. ecological, social, cultural, political, etc) to which they can contribute. The lag time between investor behavioral changes and market demands can be protracted because investors think demand may be short lived, or they are unwilling to change a tried-and-true business model and "formal" method for approaching an investment type, and because a moving market isn't necessarily easily followed, or lead. This explains why the market can be slow to accommodate the desired changes even when consumers clearly demand something other than what is offered in the marketplace.

Such is the case with land development. Millions of homes are constructed annually in conventionally designed communities that do not appear to be as desirable to a growing, increasingly sophisticated and demanding consumer pool. When the market does finally respond, it appears to be focused on cosmetic, or small, incremental changes. As such, most residential land development continues to contribute to a legacy of: a) high land consumption; b) downstream deleterious effects on water quality, flooding, deteriorating streams, wetland and other water bodies; c) creating petroleum- fuel- consumptive and automobile-dependant designs that contribute to deteriorating air and water quality, human quality of life; d) burdensome development maintenance costs that appear to exceed tax revenues now and in the future; and e) lax or declining quality and quantity of open space for the quiet enjoyment of life.

Once the market demands something different, the two biggest impediments to market transformation are regulation and investor behavior, and both have been slow to change. Regulation is often the most difficult to adapt to changes, and both can lag market demand for years, even when everyone knows they are operating with antiquated, under-performing regulations, and in the face of measurable and failed policies on the ground. Such failures include

increasingly problematic flooding and poor water quality, and costly public financial burdens for maintaining infrastructure and questionable adequacy of long term funding for their upkeep (e.g. roads, sewers, emergency services, etc) and often near-term and definitely long-term under funding of their repair, upkeep, or replacement).

Ecologically designed conservation developments (Arendt, 1996; Apfelbaum et al, 1995; Apfelbaum et al, 1997) start with a different premise, by identifying the land to avoid and protect, and some designers (Apfelbaum et al, 1995) also integrate restoration of degraded lands early, and may also integrate alternative stormwater management (AES, 1993) and trails and other important features as major organizing elements in the design. While the conventional development design process may integrate some of these features where they provide a tangible benefit or if they are often requested to do so, even stormwater is integrated often very late in the conventional design process. Trail links are more commonly integrated then just a few years ago in conventional developments.

Many communities are moving their policies toward allowing more development design flexibility and adopting ordinances to encourage a greater level of conservation. These include a requirement for more open space, linking communities with trails and greenways, and also trying to solve pending and future predicted problems with flooding, declining ground water and potable water supplies, and looming water quality issues. National, State and County policies also appear to be changing and becoming more focused in encouraging and requiring that conservation design principles be more pivotal in the design of developments. Such changes include the tightening Federal Clean Water Act restrictions on wetland impacts; increasingly stringent stormwater management requirements focused on water quantity management; and integrating a requirement for water quality (see USEPA Best Management practices manuals, etc).

This paper is focused on summarizing some case studies AES has documented through our 30+ years in the design of conventional and conservation communities. The basic principles of conservation development and ecological design used by AES, Inc. include the following:

- Clustered housing
- Smaller lots
- Distinct neighborhoods that are linked through green- and open-space systems.
- Use of less natural resources because of the consolidation of build-out
- Mixed use to reduce requirements for automobile travel for basic needs, etc.
- Restoration of open space, not just allowing the land to lay fallow
- Extensive trail networks and all homes having visual and/or pedestrian access to open-space systems
- Communities engaged in land management through traditions (e.g. midwestern prairie prescribed burning) and education
- Beneficial use of open space for functional needs – stormwater management, ground-water recharge to serve potable water supply replenishment needs, flood-damage reduction and mitigation of down-stream problems, elimination of stormwater sewers and piped systems, greenways, passive and active parks, etc.

Deployment of these principles involves the integration of built and open-space areas by placing homes adjacent to the open space. Alternative stormwater management, recreation, wildlife and aesthetic enjoyment all occur in this open-space system. With this approach, ecologically-designed conservation developments are sometimes assumed to be more expensive because land is being set aside or "given away" to open space (and thus not divided into lots) with the additional burden of restoring that open space. This perception has been part of the reason this study was conducted. This paper summarizes results from the comparison of conceptual design plans (not built projects) of conventional vs. ecologically designed conservation developments (i.e. paired conventional and conservation plans) for 10 sites. The economic data used here was jointly prepared with our clients and once constructed, as a follow-up

assessment, we will be able to provide actual construction costs rather than the projections provided here. We also intend to provide the top-side economics – that is, lot and home sales velocity, price-point and premiums (or losses) over competitive market-area projects.

The only comparison of built projects that works is a scenario where there is a built ecologically designed conservation development "just down the road" from a built conventional development. But it is still very difficult to compare the cost savings inherent to one design approach over another, because they remain two separate sites – each with its own idiosyncrasies affecting construction costs and planning differences. And so this brings us back to the efficacy of comparing costs between two conceptual "paper" alternatives on the same site.

Prior Analyses

Previous cost-comparison research has varied greatly; from studying real-estate appreciation with homes next to open space to reducing flooding risk by using conservation-development practices. Northern Illinois Planning Commission (NIPC, 2005) compared the economic costs of designing and building conservation versus conventional developments, primarily as it relates to stormwater management practices. Comparing the assessed costs – site preparation (clearing and grading); lot clustering; stormwater, sewer, and water supply infrastructure installation and maintenance; landscaping installation and maintenance; and paving – the authors showed cost savings ranging from $2500 to $3700 per lot.

Reacting to concern over the marketability and price of smaller lots in conservation developments, a study (Lacy, 1995) compared appreciation rates in clustered housing developments with permanently preserved open space and conventional developments. Appreciation rates for the cluster/open space development averaged 167.9% over eight years, while the rate for conventional developments was 146.8%. Lacy concluded that the spending behavior of buyers suggests an increasing desire for homes with proximity to permanently-protected lands, over demand for homes located on bigger lots without the open-space amenity.

Community infrastructure maintenance costs were investigated by Stephenson et al (2001) who found, "cluster development would have a negligible to positive consequence on local government costs." The study determined that cluster developments would have some advantages, including the reduction of infrastructure maintenance due to reduced infrastructure, and other studies have found a correlated cost savings from reduced downstream flooding risk, a cost not always reviewed or calculated by municipalities (NIU, 2004 and IDNR and CDF, 2004).

The quality of the open space has been evaluated to quantify the cost/benefit of green space on home values. Lot-value premiums adjacent to natural open space ranged from a 6% to 32% increase across various site studies.

NOAA (2005-2006) quantified the cost savings and environmental and social impacts of different development types. By comparing conventional, conservation and new-urbanist project design construction costs, potential new revenue and conceptual estimates for return on development investment, remediation costs for water quality and cost of government services. Conservation development had the lowest cost to develop, while new-urbanism had the highest potential net revenue and both had the same positive attributes for a rapid return on developer investment, as well as reduced cost of local governmental services. The Western Reserve Conservation & Development Council, (1998) identified increased lot premiums and faster lot sales (absorption) with a conservation-development design approach. At Laurel Springs (Bainbridge, Ohio), lots abutting open space sold for a 10% premium over conventional lots, and lot absorption increased by a minimum of .5 units per month. The residual profit to the developer was 55% with conservation development versus 27% with conventional. At Thornbury (Solon, Ohio), conservation lot premiums were 10% over conventional lots. A cost savings per lot of $10,000, or 17.5% was found in compari-

son with conventional lots. Conservation-development lot absorption rates were more than twice conventional lots (eight years to sell out versus 17 years).

Currently, there are few economic comparisons of conservation vs. conventional development. At the same time there is increased interest for these data and understandings. From our review, we learned that most comparisons used different parameters, measures and definitions and while useful, this lack of standardization has made it difficult to extract unifying and predictable principles. The following methodology provides a format for comparison by the marketplace and investors, as the review highlighted a need for a standardized method and metrics for making, evaluating and reporting such comparisons.

Methods

This paper is focused on presenting a standardized method for comparing conservation and conventional residential developments and providing the summary of this comparison. As a result of the focus on this method, only ten example projects are provided here. The following criteria were used for selecting the sample projects included in this paper:

1. Personal experience and involvement by the authors on each project
2. The project is a residential subdivision of the Upper Midwest
3. The project had a both a baseline "conventional" and an ecologically-designed "conservation" concept plan.
4. Sewer service and water supply requirements are the same for both "conventional" and "conservation" concept plans.
5. Both project designs meet local ordinances (i.e., approvable under standard subdivision, P.U.D., or conservation ordinances).
6. All projects are Greenfield developments (i.e. project sites had not been previously developed).

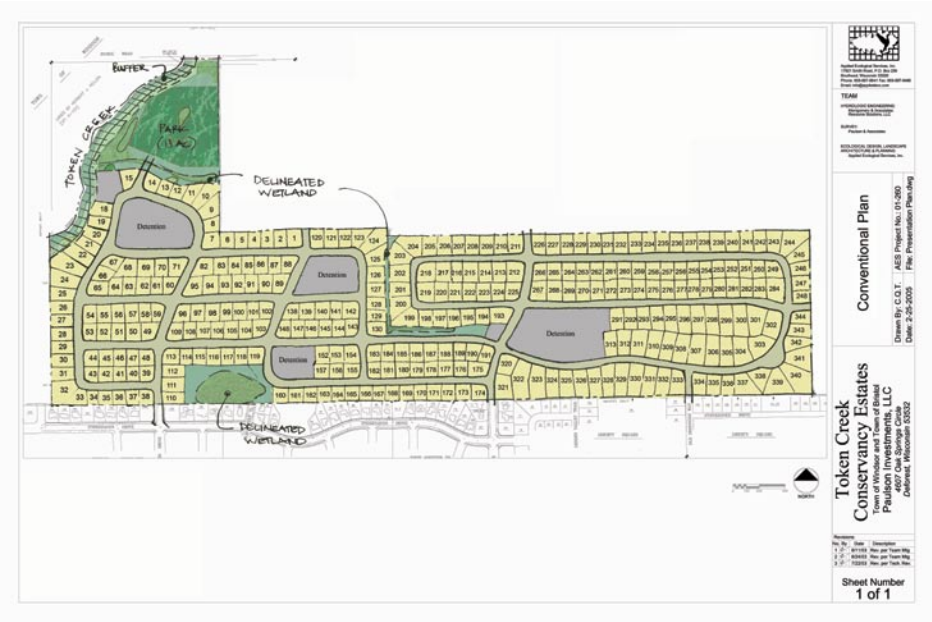
In addition, the following criteria were used for costing the sample projects included in this paper:

1. All costs and cost criteria were also designed or selected to adhere to the following criteria: Cost Categories for which data from each development had to be available are included in Table 1, and include Grading, Roadway, Storm Sewer, Sanitary, Water Main, Erosion-Control Maintenance, Trails, Landscape/Restoration, Amenities, and Contingencies/Engineering/Legal.
2. Unit Costs for each Cost Category are held constant across all projects (Unit Costs were averaged from Engineer's Opinion of Probable Cost data sets, Developer's Pro-Forma, and AES data).
3. Measurement "take-offs" from plans were systematically measured for the following variables: Total Acreage of site, Linear Feet (L.F.) of Roadway, Width of Road Pavement, Width of Right-Of-Way (R.O.W.), Total Number of Lots, Area in Lots (total area covered by lots), Acreage of Open Space, and Linear Feet (L.F.) of Trails.

Most projects had open-space acreage over 50% of the total site acreage when designed as a conservation development. In addition, the conservation plans needed to be responsive to natural resources, aesthetic quality of open spaces, restoration potential of natural resource, and needed to use alternative stormwater management principles. In addition, the projects had to be broadly applicable to other geographic settings, regulatory climates, and market settings in the USA. The cost-comparison tool uses a spreadsheet which allows development projects to be compared individually and in summary. The process for populating the spreadsheet to make the comparison used the following steps:

1. Plan measurements ("take offs") are made and entered into the data input chart for the given project.

Figure 1: Individual Project Comparison



<u>Conventional Development</u>
Single Family Units: 307 (20,000 SF)
Multi-Family: 0 units
Total Site Acreage: 203 Ac
Open Space: 11.1 Ac (5%)

<u>Conservation Development</u>
Single Family Units: 310 (10,000 SF)
Multi-Family: 30 units
Total Site Acreage: 203 Ac
Open Space: 105.8 Ac (52%)

Table 1: Construction Cost Categories, Calculation Method and Assumptions

Cost Category	Calculation Method	Assumptions	Notes
Grading	(From Take-Offs)	Strip Topsoil = ((Built Acreage) x (12" cut)x ($/c.y.)) + General Lot Grading at $0.20 per s.f. + Clearing & Grubbing = (Average Lot Size x .2 sq. ft.) + Seeding = Area in lots + Erosion Control = Perimeter of Site	Assumes prior agricultural site
Roadway	(From Take-Offs)	(LF Road) x (Pavement Width) + (Curbs, Sidewalks)	
Storm Sewer	(Extrapolated)	LF Road (Conservation = (Total cost of improvement x .5)	Conservation developments are assumed to have alternative storm-water, therefore, less hard infra-structure costs.
Sanitary	(Extrapolated)	LF Road (If lot area is greater than 40,000 sq. ft., no watermain are assumed)	
Watermain	(Extrapolated)	LF Road (If lot area is greater than 40,000 sq. ft., no watermain are assumed)	
Erosion Control Maintenance	(From Take-Offs)	Wrap Entire Perimeter (Actually = sq. rt. of total acreage x 4	
Trails	(From Take-Offs)	Internal Distribution System of Existing Offsite	
Landscape/Restoration	(From Take-Offs)	Per Acre over Entire Site (Conventional = (Developed site acres) x $1,400/AC) (Conservation = ((Developed site acres) x $1,400/AC) + (Open-Space Acres x $ 5,000/AC)))	Typical landscape installation is as-sumed for developed areas, such as an entry feature, restorationof natu-ral plant communitiesis assured for open-space areas in conservation developments.
Amenities	(From Take-Offs)	LF Roadway (Includes street trees, street lights, asphalt and limestone trails)	
Contingencies/Engineering/Legal	(From Take-Offs)	(25%) x (Total Construction Costs)	

* Cost calculations are based on four previous development pro-forma in the upper-Midwest, supplied by developers

Figure 2a: Probable Costing Spreadsheet - Conventional

PRELIMINARY OPINION OF PROBABLE COST - CONVENTIONAL DEVELOPMENT					DEVELOPMENT DATA	Unit	Amt.	%
Project Name	Token Creek Conservancy Estates		Known Site Ac.	203	Total Site Acreage	AC	203.00	100%
PROJECT #	01-260				Total Open Space	AC	11.11	5%
DATE:	4-Jul-05				Buildable Acreage	AC	203.00	100%
					Built Acreage (Lots + ROW)	AC	191.89	95%
					Constrained Open Space Remaining in O/S	AC	0.00	0%
					Developable Open Space Remaining in O/S	AC	11.11	5%
					Total Lots		307	
					Avg. Lot Size	SF	22,380	
					LF of Roadway	LF	24,800	
					Street Pavement Width	Feet	28.0	
					ROW Width	Feet	60	
					Area in Lots	SF	6,870,719	78%
					Area in ROW	SF	1,488,000	17%

CONVENTIONAL DESIGN

ITEM	BASIS/RULE OF THUMB	(Formula)	AMOUNT	UNIT	DESCRIPTION	UNIT COST	TOTAL COST
GRADING							
	Assumes prior AG. Field-type site	$100/acre	192	AC	CLEARING & GRUBBING	$100.00	$19,189
	Assumes 12" deep over (Developed Area?)/entire site, (but sometimes 8"?)		245,267	CY	STRIP TOPSOIL	$1.25	$306,583
	Unit Cost based on +/-12,570 sf lot/$2,500 or $0.20/sf		307	LOTS	GENERAL LOT GRADING	$3,237	$993,862
	Assumes wrap of entire site perimeter	4 x sq.rt. Of Tot Ac.	11,895	LF	SILT FENCING	$1.60	$19,031
	Seeding of Development Area minus Road		158	AC	SEED SITE	$550.00	$86,752
						GRADING SUBTOTAL	$1,425,418
ROADWAY							
	Usually 2 tracking drives per site		2	EA	GRAVEL TRACKING DRIVE	$1,000.00	$2,000
	Per LF of CL of Roadway		24,800	LF	SHAPE, ROLL, AND COMP. SUBGRADE	$2.75	$68,200
	2.5 Tons/CY (thickness based on local req's)	assumed 10" thick base x road paved area	53,580	TON	10" THICK CRUSHED LIMESTONE BASE	$10.00	$535,802
	assumes both sides of street	2 x LF Roadway	49,600	LF	30" CURB AND GUTTER	$7.00	$347,200
	2 x LF of roadway		49,600	LF	BACKFILL BEHIND CURB	$0.30	$14,880
ssumes construction of Shoulder & Swale is roughly equivelent in price to curb and gutte			0	LF	SHOULDER & SWALE	$7.30	$0
	Width of Pavement x LF of roadway		77,156	SY	2 THICK BINDER COURSE	$3.60	$277,760
			77,156	SY	1-1/2" SURFACE COURSE	$2.55	$196,747
			77,156	SY	TACK COAT	$0.40	$30,862
	(R/W width - Pavement Width) x LF of Road		88,178	SY	PLACE 4" TOPSOIL & RESTORE TERRACE	$2.50	$220,444
	Matches LF of curb x 5' wide = sf of Sidewalk		248000	SF	4" thick sidewalk 5' wide w/base	$2.50	$620,000
Intersection Improvements (does it include: Turn Lane additions/signalization?)			0	EA	STATE HWY INTERSECTION	$648,229.00	$0
						ROADWAY SUBTOTAL	$2,313,896
STORM SEWER							
	Approx.1/2 of LF of Road (includes all Storm line sizes)			LF	**Average of total Storm Sewer all sizes**	$31.22	$0
	55% of total LF of storm line		6,820	LF	12" STORM SEWER (SPOIL BACKFILL)	$27.50	$187,550
	24% of total LF of storm line		2,976	LF	15" STORM SEWER (SPOIL BACKFILL)	$33.00	$98,208
	18% of total LF of storm line		2,232	LF	18" STORM SEWER (SPOIL BACKFILL)	$38.50	$85,932
	3% of total LF of storm line		372	LF	≥24" STORM SEWER (SPOIL BACKFILL)	$40.70	$15,140
	Approx. 1 inlet/96 feet of Storm Sewer Line (includes all inlets)		129	EA	STORM INLET	$1,000.00	$129,167
	Approx. 1 MH per 290 LF of Storm line		43	EA	42/48" STORM MH W/ GRATE	$1,200.00	$51,310
	Avg. 83' per lot		25,481	LF	6" Laterals and Sumpline	$17.00	$433,177
	Approx. 1 end section (incl. All sizes) per 430 LF of Storm line			EA	**Average of total End Sections all sizes**	$500.00	$0
	1 12" End Section per 1050 LF of 12" Storm Line		6	EA	12" END SECTION	$350.00	$2,273
	1 15" End Section per 275 LF of 15" Storm Line		11	EA	15" END SECTION	$450.00	$4,870
	1 18" End Section per 345 LF of 18" Storm Line		6	EA	18" END SECTION	$600.00	$3,882
	1 ≥24" End Section per 150 LF of ≥24" Storm Line		2	EA	≥24" END SECTION	$1,000.00	$2,480
	7.5 SY per End Section		197	SY	RIPRAP	$50.00	$9,850
	Typ. Allow 5% of site area for Deten. Basins? 1 basin (1.5 ac.) p	$600/Ac x total site acreage	203	AC	STORMWATER MANAGEMENT BASINS	$600	$121,800
						STORM SEWER SUBTOTAL	$1,145,639
SANITARY SEWER							
	1.086 x LF of Road		26,933	LF	8" SAN. SEWER W/SPOIL BACKFILL	$35.00	$942,648
	35 LF per Lot		10,745	LF	4" SANITARY LATERAL	$20.00	$214,900
	1 San MH per 156 LF of San Sewer line		173	EA	48" SAN MH W/CHIMNEY SEALS,FRAME & LIDS	$2,000.00	$345,292
						SANITARY SUBTOTAL	$1,502,840
WATERMAIN							
	Total W/L Same as LF of Roadway			**LF**	**Average of total W/L all sizes**	**$57.00**	$0
	.60 x LF Road		14,880	LF	8" WATERMAIN (DI W. SPOIL BACKFILL)	$38.00	$565,440
	.25 x LF Road		6,200	LF	12" WATERMAIN (DI W/GRAN BACKFILL)	$50.00	$310,000
	.15 x LF Road (NOTE: May need to add Extension to Ex. Main)		3,720	LF	24" WATERMAIN (DI W/ GRAN. BACKFILL)*	$110.00	$409,200
	1 Hydrant per 575 LF of W/L		20	EA	HYDRANT ASSEMBLIES	$2,500.00	$50,000
	1 Valve per 340 LF of 8" W/L		44	EA	8" GATE VALVES	$800.00	$35,012
	1 Valve per 340 LF of 12" W/L		18	EA	12" GATE VALVES	$1,000.00	$18,235
	1 Valve per 435 LF of 24" W/L		9	EA	24" GATE VALVES	$4,000.00	$34,207
	Typically "Loop" req'd with 2 connections (Tapping Tees & Valves)		2	EA	CONNECTION TO EX. WM	$5,000.00	$10,000
	Approx. 35 LF per lot		10,745	LF	1" COPPER LATERAL	$21.00	$225,645
						WATERMAIN SUBTOTAL	$1,657,739
EROSION CONTROL MAINTENANCE							
	Approx. $3 per LF of silt fence		11,895	LF	EROSION CONTROL MAINTENANCE	$3.00	$35,684
						MISCELLANEOUS SUBTOTAL	$35,684
OFFSITE SANITARY SEWER							
	Connection Distance to Ex. Offsite line		750	LF	8" SAN. SEWER W/SPOIL BACKFILL	$35.00	$26,250
						OFFSITE SANITARY SUBTOTAL	$26,250
LANDSCAPE/RESTORATION							
/ac for Landscape/Sod/Seed (usually represents 4% of total construction costs per Proforma Copperleaf			203	AC	Generic Landscape	$1,400.00	$284,200
						LANDSCAPE/RESTORATION SUBTOTAL	$284,200
AMENITIES							
	Per LF of street (Includes both sides of street)		24,800	LF	Street Trees	$15.00	$372,000
	"		24,800	LF	Street Lights	$25.00	$620,000
	If no actual takeoff, Avg. 25 LF of 8' wide Asphalt Trail per O/	If no actual takeoff, Total O/S x .25 x 100 LF	278	LF	Asphalt Trails 8' wide	$8.00	$2,222
	If no actual takeoff, Avg. 75 LF of 6' wide Limestone Trail per (	If no actual takeoff, Total O/S x .75 x 100 LF	833	LF	Limestone Trails 6' wide	$6.00	$5,000
						AMENITIES SUBTOTAL	$999,222
					SUBTOTAL		$9,390,888
					CONTINGENCIES/ENG/LEGAL (25%)		$2,347,722
					TOTAL OPINION OF COST		$11,738,610
	TOTAL SINGLE LOTS-			307			
	TOTAL UNITS (DUPLEXES)			0			
COST PER UNIT				$38,237			
COST PER FOOT				473			

Figure 2b: Probable Costing Spreadsheet - Conservation

PRELIMINARY OPINION OF PROBABLE COST -	**CONSERVATION DEVELOPMENT**				**DEVELOPMENT DATA**	**Unit**	**Amt.**	**%**
Project Name	**Token Creek Conservancy Estates**		**Known Site Ac.**	**203**	**Total Site Acreage**	**AC**	**203.00**	**100%**
PROJECT #	01-260				**Total Open Space**	**AC**	**105.83**	**52%**
DATE:	**4-Jul-05**				**Buildable Acreage**	**AC**	**203.00**	**100%**
					Built Acreage (Lots + ROW + Multifamily)	**AC**	**97.17**	**48%**
					Constrained Open Space Remaining in O/S	**AC**	**0.00**	**0%**
					Developable Open Space Remaining in O/S	**AC**	**105.83**	**52%**
					Total Lots		**340**	
					Avg. Lot Size	**SF**	**9,993**	
					LF of Roadway	**LF**	**16,700**	
					Street Pavement Width	**Feet**	**28.0**	
					ROW Width	**Feet**	**50**	
					Area in Lots	**SF**	**3,397,680**	**38%**
					Area in ROW	**SF**	**835,000**	**9%**
CONSERVATION DESIGN								
ITEM	**BASIS/RULE OF THUMB**	**(Formula)**	**AMOUNT**	**UNIT**	**DESCRIPTION**	**UNIT COST**	**TOTAL COST**	
GRADING								
	Assumes prior AG. Field-type site	$100/acre	97	AC	CLEARING & GRUBBING	$100.00	$9,717	
	Assumes 12" deep over (Developed Area?)/entire site, (but sometimes 8"?)		156,766	CY	STRIP TOPSOIL	$1.25	$195,957	
	Unit Cost based on +/-12,570 sf lot/$2,500 or $0.20/sf		340	LOTS	GENERAL LOT GRADING	$1,999	$679,536	
	Assumes wrap of entire site perimeter	4 x sq.rt. Of Tot Ac.	11,895	LF	SILT FENCING	$1.60	$19,031	
	Seeding of Development Area minus Road		78	AC	SEED SITE	$550.00	$42,900	
						GRADING SUBTOTAL	**$947,142**	
ROADWAY								
	Usually 2 tracking drives per site		2	EA	GRAVEL TRACKING DRIVE	$1,000.00	$2,000	
	Per LF of CL of Roadway		16,700	LF	SHAPE, ROLL, AND COMP. SUBGRADE	$2.75	$45,925	
	2.5 Tons/CY (thickness based on local req's)	assumed 10" thick base x road paved area	36,080	TON	10" THICK CRUSHED LIMESTONE BASE	$10.00	$360,802	
	assumes both sides of street	2 x LF Roadway	33,400	LF	30" CURB AND GUTTER	$7.00	$233,800	
	2 x LF of roadway		33,400	LF	BACKFILL BEHIND CURB	$0.30	$10,020	
	assumes construction of Shoulder & Swale is roughly equivelent in price to curb and gutter		0	LF	SHOULDER & SWALE	$7.30	$0	
	Width of Pavement x LF of roadway		51,956	SY	2 THICK BINDER COURSE	$3.60	$187,040	
			51,956	SY	1-1/2" SURFACE COURSE	$2.55	$132,487	
			51,956	SY	TACK COAT	$0.40	$20,782	
	(R/W width - Pavement Width) x LF of Road		40,822	SY	PLACE 4" TOPSOIL & RESTORE TERRACE	$2.50	$102,056	
	Matches LF of curb x 5' wide = sf of Sidewalk		167000	SF	4" thick sidewalk 5' wide w/base	$2.50	$417,500	
	Intersection Improvements (does it include: Turn Lane additions/signalization?)		0	EA	STATE HWY INTERSECTION	$648,229.00	$0	
						ROADWAY SUBTOTAL	**$1,512,412**	
STORM SEWER								
	Approx.1/2 of LF of Road (includes all Storm line sizes)			LF	**Average of total Storm Sewer all sizes**	$31.22	$0	
	55% of total LF of storm line		4,593	LF	12" STORM SEWER (SPOIL BACKFILL)	$27.50	$126,294	
	24% of total LF of storm line		2,004	LF	15" STORM SEWER (SPOIL BACKFILL)	$33.00	$66,132	
	18% of total LF of storm line		1,503	LF	18" STORM SEWER (SPOIL BACKFILL)	$38.50	$57,866	
	3% of total LF of storm line		251	LF	≥24" STORM SEWER (SPOIL BACKFILL)	$40.70	$10,195	
	Approx. 1 inlet/96 feet of Storm Sewer Line (includes all inlets)		87	EA	STORM INLET	$1,000.00	$86,979	
	Approx. 1 MH per 290 LF of Storm line		29	EA	42/48" STORM MH W/ GRATE	$1,200.00	$34,552	
	Approx. 1 end section (incl. All sizes) per 430 LF of Storm line			EA	**Average of total End Sections all sizes**	$500.00	$0	
	1 12" End Section per 1050 LF of 12" Storm Line		4	EA	12" END SECTION	$350.00	$1,531	
	1 15" End Section per 275 LF of 15" Storm Line		7	EA	15" END SECTION	$450.00	$3,279	
	1 18" End Section per 345 LF of 18" Storm Line		4	EA	18" END SECTION	$600.00	$2,614	
	1 ≥24" End Section per 150 LF of ≥24" Storm Line		2	EA	≥24" END SECTION	$1,000.00	$1,670	
	7.5 SY per End Section		133	SY	RIPRAP	$50.00	$6,633	
	Typ. Allow 5% of site area for Deten. Basins? 1 basin (1.5 ac.) pe	$600/Ac x total site acreage	203	AC	STORMWATER MANAGEMENT BASINS	$600	$121,800	
						STORM SEWER SUBTOTAL	**$519,544**	
SANITARY SEWER								
	1.086 x LF of Road		18,136	LF	8" SAN. SEWER W/SPOIL BACKFILL	$35.00	$634,767	
	35 LF per Lot		11,900	LF	4" SANITARY LATERAL	$20.00	$238,000	
	1 San MH per 156 LF of San Sewer line		116	EA	48" SAN MH W/CHIMNEY SEALS,FRAME & LIDS	$2,000.00	$232,515	
						SANITARY SUBTOTAL	**$1,105,282**	
WATERMAIN								
	Total W/L Same as LF of Roadway			**LF**	**Average of total W/L all sizes**	**$57.00**	$0	
	.60 x LF Road		10,020	LF	8" WATERMAIN (DI W. SPOIL BACKFILL)	$38.00	$380,760	
	.25 x LF Road		4,175	LF	12" WATERMAIN (DI W/GRAN BACKFILL)	$50.00	$208,750	
	.15 x LF Road (NOTE: May need to add Extension to Ex. Main)		2,505	LF	24" WATERMAIN (DI W/ GRAN. BACKFILL)*	$110.00	$275,550	
	1 Hydrant per 575 LF of W/L		20	EA	HYDRANT ASSEMBLIES	$2,500.00	$50,000	
	1 Valve per 340 LF of 8" W/L		29	EA	8" GATE VALVES	$800.00	$23,576	
	1 Valve per 340 LF of 12" W/L		12	EA	12" GATE VALVES	$1,000.00	$12,279	
	1 Valve per 435 LF of 24" W/L		6	EA	24" GATE VALVES	$4,000.00	$23,034	
	Typically "Loop" req'd with 2 connections (Tapping Tees & Valves)		2	EA	CONNECTION TO EX. WM	$5,000.00	$10,000	
	Approx. 35 LF per lot		11,900	LF	1" COPPER LATERAL	$21.00	$249,900	
						WATERMAIN SUBTOTAL	**$1,233,850**	
MISCELLANEOUS								
	Approx. $3 per LF of silt fence		11,895	LF	EROSION CONTROL MAINTENANCE	$3.00	$35,684	
						MISCELLANEOUS SUBTOTAL	**$35,684**	
OFFSITE SANITARY SEWER								
	Connection Distance to Ex. Offsite line		750	LF	8" SAN. SEWER W/SPOIL BACKFILL	$35.00	$26,250	
						OFFSITE SANITARY SUBTOTAL	**$26,250**	
LANDSCAPE/RESTORATION								
	Remaining (Total - O/S) site acres x $1400/Ac		**97**	**AC**	**Generic Landscape**	**$1,400.00**	**$136,037**	
	Total Open Space Acres x $5000/Ac		**106**	**AC**	**Restoration (Avg. Savanna, Prairie, Wetland)**	**$5,000.00**	**$529,155**	
						LANDSCAPE/RESTORATION SUBTOTAL	**$665,192**	
AMENITIES								
	Per LF of street (Includes both sides of street)		16,700	LF	Street Trees	$15.00	$250,500	
	"		16,700	LF	Street Lights	$25.00	$417,500	
	If no actual takeoff, Avg. 25 LF of 8' wide Asphalt Trail per O/S	If no actual takeoff, Total O/S x .25 x 100 LF	8,030	LF	Asphalt Trails 8' wide	$8.00	$64,240	
	If no actual takeoff, Avg. 75 LF of 6' wide Limestone Trail per C	If no actual takeoff, Total O/S x .75 x 100 LF	0	LF	Limestone Trails 6' wide	$6.00	$0	
						AMENITIES SUBTOTAL	**$732,240**	
					SUBTOTAL		**$6,777,596**	
					CONTINGENCIES/ENG/LEGAL (25%)		**$2,347,722**	
					TOTAL OPINION OF COST		**$9,125,318**	
	TOTAL SINGLE LOTS-			**310**				
	TOTAL UNITS (Townhouse)			**30**				
COST PER UNIT				**$26,839**				
COST PER FOOT				**546**				

2. Calculations are run from either direct take-off plan measurements, or by projection. When projecting, start with a known takeoff measure (e.g. LF of Road) to establish estimated values for another cost category (e.g. LF of waterline). This method is necessary at a conceptual level of detail because utilities have not been finalized. This assumes that the LF of roadway will closely correlate to the LF of other utilities that typically follow the roadway layout. Thus, efficiencies that can be realized by using spurred utilities and cross-over layouts with shared main utility lines have not been applied unless both strategies could be used in the conventional and conservation design plans. To correlate the LF of utility runs and LF of roadways, an approximate value is calculated using a multiplier derived from averaging baseline project data (see Costing Method Criteria #1 in Table 1
3. When all projects are in the cost-comparison tool, generate a summary chart.

Results and Discussions

Single-Development Comparison

One of the ten projects is highlighted herein to demonstrate the methods used for comparison. This 200^{+}-acre project, identified here as Token Creek Conservancy Estates, is located on the northern edge of Sun Prairie, Wisconsin. There is an existing wetland at the south edge of the site, and Token Creek, a DNR Class III Trout Stream, constitutes the western boundary of the site. This creek is the largest of all tributaries to Lake Mendota in the heart of Madison, Wisconsin. Both conventional and conservation concepts shown here assume city sewer and water. The conventional concept accommodates 307 lots ranging from 15,000 to 25,000 sf, while the conservation concept has 314 ¼-acre lots plus 30 townhouse condominium units. Stormwater management in the conventional plan consists of a typical network of curb & gutter, curb inlets and pipes running into a few detention basins on site. The conservation concept, by contrast, utilizes the Stormwater Treatment Train™ (STT) approach consisting of a series of open prairie, raingardens, bioswales, and wetland biofiltration cells, all contributing to comparatively higher water quality as these natural systems remove sediment, phosphates, nitrogen and other pollutants. The STT™ meets or exceeds requirements for stormwater management, but more importantly, because it promotes infiltration, further addresses the issue of groundwater recharge in maintaining base flow to Token Creek as well as reducing the thermal impact of stormwater runoff on cold-water trout habitat (infiltrated water is naturally cooled before entering the creek).

An example graphic comparison (Figure 1) and probable costing spreadsheets used to compute the cost of conventional and conservation design (Figure 2a and 2b) show the specific elements of a development budget and pro-forma. In this summary of one project (Table 2) the overall averaged savings by using an ecological conservation design for the development was 22%, or $2,613,291. On a per-unit basis the savings was 30% and $11,397. The primary areas of savings in this particular example project included the reduced or nearly eliminated stormwater sewer systems (55% reduction and $626,095 saved), roads (35% reduction and $801,484 saved), and grading (34% reduction and $478,276 saved) while more money was spent in the landscaping category because the additional cost of restoration was added over and above the conventional landscaping budget for the project.

The benefit of being able to compare individual development plans is that each conceptual plan can be easily and promptly compared. This process can quickly inform a design team of where possible excessive costs are included in a plan, and this can focus the team to further refine and do value-added design. The other benefit is that citizens can use the averaged savings found in Table 3, and apply those averaged savings to other proposed conventional residential developments to provide other community members, design community members and policy and regulatory persons with the potential benefits of a conservation design approach on the same property.

*The Stormwater Treatment Train™ (STT™) is a registered trademark of Applied Ecological Services, Inc. (AES)

Table 2: Token Creek Cost Comparison Summary				
Description	Conventional Cost	Conservation Cost	$ Change	% Change
GRADING SUBTOTAL	$1,425,418	$947,142	$478,276	-34%
ROADWAY SUBTOTAL	$2,313,896	$1,512,412	$801,484	-35%
STORM SEWER SUBTOTAL	$1,145,639	$519,544	$626,095	-55%
SANITARY SUBTOTAL	$1,502,840	$1,105,282	$397,558	-26%
WATERMAIN SUBTOTAL	$1,657,739	$1,233,850	$423,889	-26%
EROSION CONTROL SUBTOTAL	$35,684	$35,684	$0	0%
OFFSITE SANITARY SUBTOTAL	$26,250	$26,250	$0	0%
LANDSCAPE/RESTORATION SUBTOTAL	$284,200	$665,192	-$380,992	134%
AMENITIES SUBTOTAL	$999,222	$732,240	$266,982	-27%
CONTINGENCIES/ENG/LEGAL (25%)	$2,347,722	$2,347,722	$0	0%
Totals for Project	**$11,738,610**	**$9,125,318**	$2,613,291	**-22%**
Totals Per Unit	**$38,237**	**$26,839**	$11,397	**-30%**

Multiple-Development Comparison of Ten Projects

Table 3 shows the specific averaged elements of a development budget and proforma. In this summary of ten projects the overall averaged savings by using ecological conservation design for the development was 10%, while on a per-unit basis the savings was 25%. This difference in percentages is attributable to the fact that on seven of the 10 sample projects, more units are being developed with the conservation-development plan than with the conventional plan. On five of the conservation developments, a portion of the additional units take the form of duplex, townhouse or condo units, providing a more diversified mix that reaches different target-market price-points and a broader demographic. Moreover, the conservation developments average 59% open space versus 14% open space on average for the conventional plans.

The primary areas of savings in the 10-project summary included the reduced or nearly eliminated stormwater sewer systems (39% overall, ranging from $6,668 or 3% saved on one project up to $974,689 or 65% on another project), reduced roadway (18% overall, ranging from $130,230 or 15% more spent on conservation development in one project, and $1,464,599 or 60% saved with conservation development in another), and reduced grading (39% overall, ranging from $73,021 or 22% on one project up to $478,276 or 54% on another). On all projects, more money was spent in the landscaping category (147% overall, ranging from $597,616 or 178% more spent on conservation on one project down to $56,500 or 95% more on another) because the additional cost of restoration was added over

and above the landscaping budget for the project.

Site preparation, and grading in particular, can be the hardest projected cost to pin down. Estimating software, volumetric equations for projecting cut/fill, difficult topography, and the potential variability in the soils themselves (shrink/swell tendencies, etc.) all tend to play havoc with the calculations necessary for solid, predictable results. With this in mind, the multiple-development comparison was run a second time with an alternative grading scenario in which greater cost is attributed to increased topsoil stripping and more involved lot grading. In the original calculation, conservation lots are stripped of topsoil to a depth of 1' and conventional lots are assumed to have that same square footage of strip plus only 6" average across the remainder of the lot; the alternate grading scenario assumes topsoil strip across the entire developed area with no "tapering off". Likewise the unit cost of $0.20/sf for general lot grading is applied evenly across the entire conventional lot with no tapering off, reflecting more involved lot grading, increased overhead costs, and/or other contingencies. Under this scenario, the cost savings with conservation development increase to a 16% average project savings and a 29% average per-unit savings. This also demonstrates that increases (regardless of cost category) to unit costs or quantities will expand the gap of cost savings between conservation development and conventional development.

Table 3: Multiple Project Cost Comparison Spreadsheet

Project:	P1	P1	P2	P2	P3	P3	P4	P4	P5	P5	P6	P6	P7	P7	P8	P8	P9	P9	P10	P10	PROJECT, BY ITEM CUMULATIVE	Range of Value among projects for each Cost Category (Least/Most Favorable Change; higher $ amounts & negative % favor conservation development)			
	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	%	$	%	$	%
Description	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Diff.	Change	Change	Least Favorable Change	Least Favorable Change	Most Favorable Change	Most Favorable Change
GRADING SUBTOTAL	$73,021	-22%	$108,602	-54%	$407,959	-49%	$385,099	-38%	$443,022	-35%	$205,163	-22%	$250,729	-45%	$96,088	-39%	$451,234	-50%	$476,276	-34%	-39%	$73,021	-22%	$476,276	-54%
ROADWAY SUBTOTAL	$84,702	-15%	$18,754	-13%	-$16,477	4%	-$130,230	15%	$1,464,599	-54%	$1,187,386	-60%	$205,168	-22%	$9,231	-4%	$9,593	-1%	$801,484	-35%	-18%	-$130,230	15%	$1,464,599	-60%
STORM SEWER SUBTOTAL	$181,611	-53%	$28,398	-33%	$6,648	-3%	$89,676	-17%	$974,689	-65%	$547,184	-51%	$210,289	-43%	$65,501	-44%	$100,491	-27%	$626,095	-55%	-30%	$6,648	-3%	$974,689	-65%
SANITARY SUBTOTAL	$41,614	-10%	-$5,765	6%	$0	0	-$218,464	37%	$850,962	-43%	$224,776	-17%	$54,236	-8%	-$15,502	9%	-$10,915	2%	$397,558	-20%	-5%	-$218,464	37%	$850,962	-43%
WATERMAIN SUBTOTAL	$44,493	-9%	-$6,141	4%	-$63,680	19%	-$232,051	33%	$905,157	-42%	$240,064	-17%	$57,705	-8%	-$16,257	7%	-$11,468	2%	$423,889	-20%	-4%	-$232,051	33%	$905,157	-42%
EROSION CONTROL SUBTOTAL	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$2,428	-8%	$0	0%	-1%	$0	0%	$2,428	-8%
OFFSITE SANITARY SUBTOTAL	$0	0%	$0	0%	$0	0	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	0%	$0	0%	$0	0%
LANDSCAPE/RESTORATION SUBTOTAL	-$56,500	95%	-$74,857	178%	-$277,472	164%	-$400,321	158%	-$407,131	147%	-$597,616	176%	-$160,341	140%	-$93,954	164%	-$220,469	112%	-$380,992	134%	147%	-$597,616	178%	-$56,500	95%
AMENITIES SUBTOTAL	$17,572	-7%	-$16,202	26%	-$94,399	51%	-$226,216	54%	$552,667	-43%	$221,666	-24%	$7,825	-2%	-$15,749	15%	-$56,521	16%	$266,982	-27%	6%	-$226,216	54%	$552,667	-43%
CONTINGENCIES/ENG/LEGAL (25%)	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	$0	0%	0%	$0	0%	$0	0%
																					AVG Project Cost Savings of Conservation over Conventional development				
By Project Cumulative % Change	$386,503	-12%	$52,789	-5%	-$37,422	1%	-$732,508	13%	$4,783,964	-34%	$2,028,622	-20%	$625,613	-13%	$29,359	-2%	$264,373	-6%	$2,613,291	-22%	-10%	-$732,508	13%	$4,783,964	-34%
																					AVG Cost Savings per Unit				
Per Unit Savings w/Conservation	$6,238	-22%	$2,399	-5%	$51,139	-39%	$15,734	-34%	$2,082	-7%	$10,876	-33%	$6,115	-16%	$11,890	-36%	$17,934	-24%	$11,397	-30%	-25%	$2,082	-5%	$51,139	-39%

Conclusion

Using the ten example projects, this multiple-project comparison shows an average 10% projected development cost-savings for ecologically designed conservation-development concepts over conventional development concepts. When the cost results were divided by the number of lots (on average, there were higher lot counts with ecologically designed conservation developments) the average cost savings per unit was even higher at 16%. Under an alternative scenario where grading costs are higher due to increased topsoil stripping and more involved lot grading, the cost savings range upward to 29% average project cost savings and 28% average per unit cost savings with conservation development.

A number of quantitative elements are clearly critical for this to be possible:

- Smaller lots: The same number or more lots (than are possible under conventional development) can front less roadway with narrower lot widths, and more open space using shallower lot depths
- Lots adjacent to quality (restored) open spaces with trails: These maintain or exceed the value of larger conventional lots (i.e. give people access to more high-quality space than they would otherwise have with a larger conventional lot)
- Shorter roads: This reduces the cost of pavement, curb and gutter, sidewalk, street trees, lamp posts, fire hydrants and other associated utilities
- Narrower roads: This reduces the cost of pavement and shortens lengths of laterals, culverts, etc. (also has a traffic-calming effect, beneficial for local streets)
- Shorter infrastructure runs based on road layout take-offs: This reduces the cost of utilities

Other benefits of ecologically designed conservation-development designs not covered in this study include:

- Smaller lots increase the flexibility of subdivision layout to work around natural resources, orient houses to quality views, and create neighborhoods
- Large open spaces enable the use of naturalized stormwater management systems, which reduces the need for (and cost of) curbs, gutters, inlets, and pipes, and increases the local water quality
- Large open spaces make better areas for habitat creation, which attracts songbirds, butterflies, etc. for homeowners' enjoyment. Trails allow homeowners to interact with natural areas and their neighbors
- When houses abut open space (the authors strive to have every home back onto or face open space), homeowners have visual access to nature by simply looking out their windows, and have direct physical access to nature by walking out their door. These have shown to also have higher lot values and faster absorption rates

This study indicates significant infrastructure cost-savings using ecologically based conservation-development designs over conventional designs. Ecologically based conservation-development design is cost-effective, and contributes to positive benefits from the open-space systems for stormwater quality, groundwater recharge, connected greenspace and restored habitat, increased biodiversity, farmland preservation, as well as increased pedestrian connectivity and enhanced interaction with nature. These benefits are already established in completed conservation developments such as Prairie Crossing (prairiecrossing.com) and the Sanctuary of Bull Valley (sanctuaryofbv.com), including some of the projects used in this study.

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