Life Cycle Analysis of Residential Brownfield and Greenfield Developments:

Case Studies of Summerset (Phase 1) at Frick Park & Cranberry Heights in Cranberry Township

Business of Brownfields Conference
Wednesday, April 21, 2010

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Objective

Identify which residential model (Greenfield vs. Brownfield) is best at mitigating green house gases (GHG)

- Perform life cycle analysis of residential developments in Southwestern Pennsylvania.
- Report emissions in Carbon Dioxide Equivalents (CO_2 E.)
- Compare results on their order of magnitude

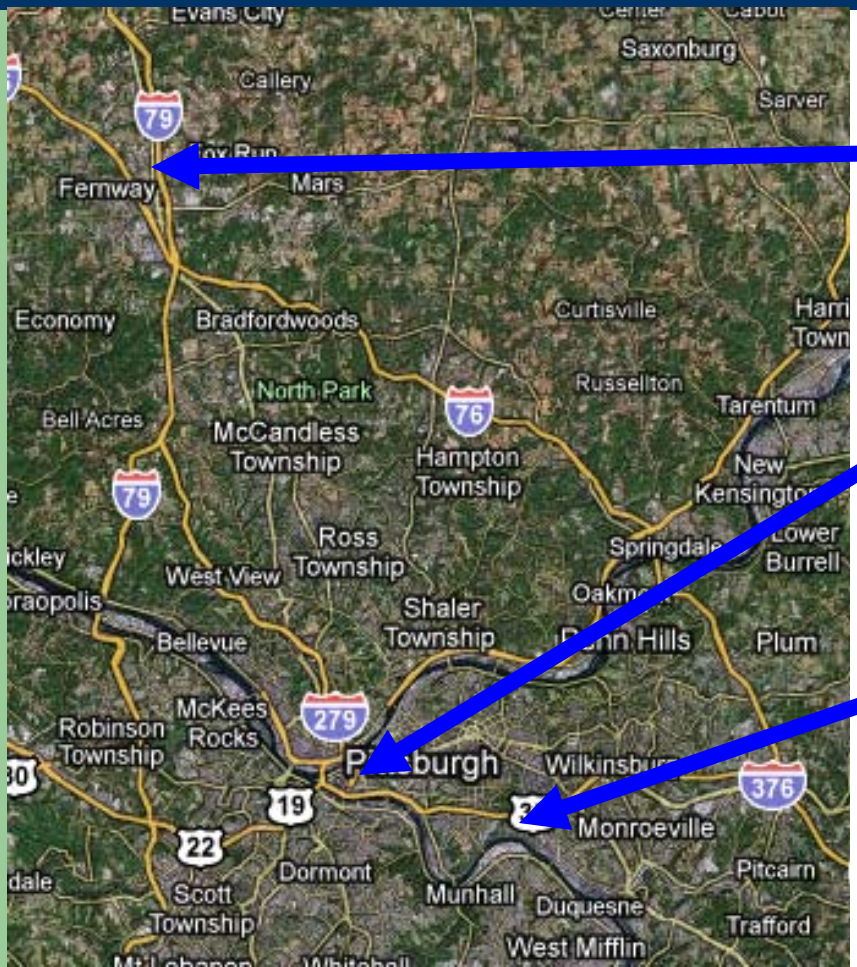
Overview

- Introduction
- Methodology
- Results
- Analysis
- Discussion

Introduction

- Brownfield
  - Phase 1 of Summerset at Frick Park
- Greenfield
  - Cranberry Heights of Cranberry Township

Site Locations



Cranberry Heights

Downtown Pittsburgh

Summerset (Phase 1)

Figure 1: Map and Satellite Image (Google Maps, 2010)

Development Comparison

	Summerset (Phase 1)	Cranberry Heights
Estimated Population	400	900
Number of Housing Units	199	244
Land Area	32 acres	270 acres
Road length	2.1 miles	3.6 miles

Methodology

The life analysis is broken into three parts:

1. Construction Phase
2. Housing Construction
3. Residential Use Phase

Data Sources

1. Economic Input Output Life Cycle Assessment (EIOLCA) tool
2. Contractor/Developer Data Sets
3. Residential Survey
4. Process Based Calculations

1. EIOLCA Tool

- Developed by the Green Design Institute at Carnegie Mellon University (www.eio-lca.net)

- Estimates the greenhouse gas (GHG) emissions attributed to purchasing goods and services from a specific industry/economic sector given a specified dollar amount.

- 2002 US National Producer Price Model

Source: EIOLCA, 2009

2. Contractor/Developer Data Sets

- The data was organized as an array of line items specifying the materials and services purchased during the construction phase.

- Material line items detailed individual purchases, their unit price, the authorized quantity, and the total cost.

3. Residential Survey

- Household Data
- Travel Behavior to Work and School
- Total Annual Mileage
- Monthly Household Utilities

4. Process Based Calculations

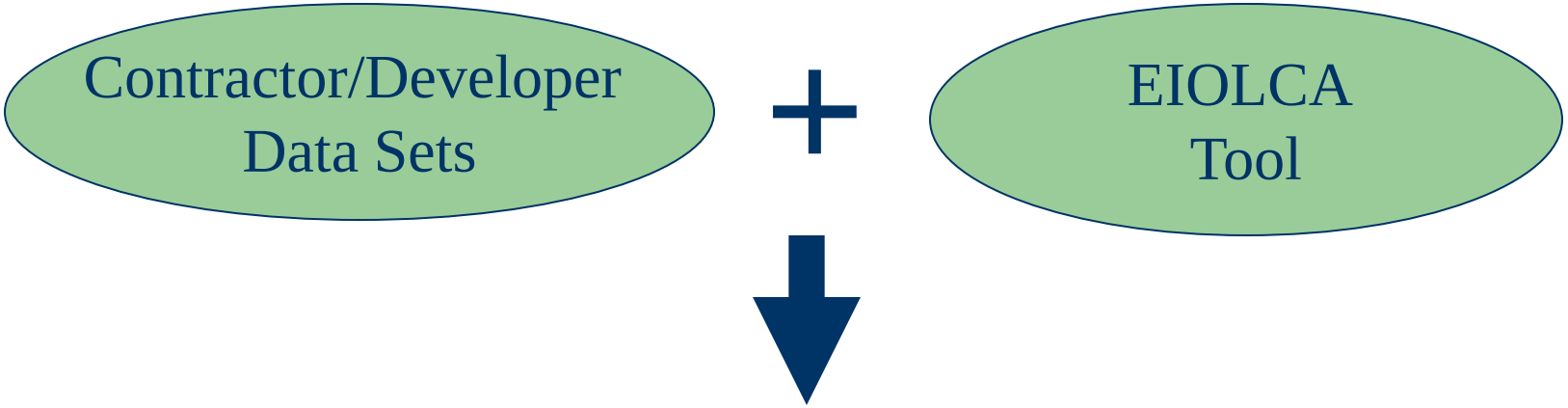
Vehicle Usage	1.04 lbs. of CO_2 E. per Vehicle Miles Traveled
Residential Electricity	20.2 lbs. of CO_2 E. per $1
Residential Gas	14.5 lbs. of CO_2 E. per $1
Residential Water	3.7 lbs. of CO_2 E. per $1
Housing Construction	1.4 lbs of CO_2 E. per $1 $120 per ft^2

Source: EIOLCA (2009), U.S. EPA (2009).

Results

- Construction Phase Data Sources:
  - Contractor/Developer
  - EIOLCA Tool
- Housing Construction Data Sources:
  - Process Based Calculations
  - EIOLCA Tool
- Residential Use Phase Data Sources:
  - Residential Survey
  - Process Based Calculations
  - EIOLCA Tool

Construction Phase



Estimated Total Emissions:

Summerset (Phase 1)	24 Million lbs of CO_2 E.
Cranberry Heights	4 Million lbs of CO_2 E.

Greenfield Infrastructure Extension

- Infrastructure:
  - Connecting Roads
  - Waterlines
  - Power lines
- Estimated Length – 2 Miles
- Scale construction phase emissions from the original 3.6 on-site miles, to represent 5.6 miles of total development.

Construction Phase

Estimated Total Emissions:

Summerset (Phase 1)	24 Million lbs of CO_2 E.
Cranberry Heights	6.2 Million lbs of CO_2 E.

Note: Adjusted for both on-site and off-site construction.

Residential Survey Results

	Summerset (Phase 1)	Cranberry Heights
Survey Response Rate	20%	31%
Avg. Residents per Unit	2	3.7
Avg. Floor Space per Unit	2,460 ft^2	2,700 ft^2
Natural Gas use per Unit	$107 per month	$201 per month
Electricity use per Unit	$112 per month	$158 per month
Water use per Unit	$32 per month	$94 per month

Residential Survey Results

	Summerset (Phase 1)	Cranberry Heights
Private Vehicle use per Unit	14,700 miles/year	30,450 miles/year
Public Transit use per Unit	1,200 miles/year	7,550 miles/year
Average Driving Distance to Work	5.5 miles	21 miles
Average Driving Distance to School	3 miles	6 miles

Housing Construction

	Summerset (Phase 1)	Cranberry Heights
Estimated Total Floor Space	490,000 ft^2	660,000 ft^2
Estimated Total Cost	$59 Million	$79 Million
Estimated Total Emissions	80 Million lbs. of CO_2 E.	110 Million lbs. of CO_2 E.

Residential Use Phase

Emissions (lbs. of CO_2 E./year)

	Summerset (Phase 1)	Cranberry Heights
Natural Gas	18,600	35,000
Electricity	27,200	38,300
Water	1,400	4,100
Private Vehicle	15,300	31,700
Public Transit	1,300	7,900
Total per Unit	64,000	117,000
Total per Capita	32,000	31,600

Analysis

- Initial & One-time Emissions:
  - Construction Phase
  - Housing Construction
- Annual & On-going Emissions:
  - Residential Use Phase

Analysis of Initial Emissions
(lbs. of CO_2 E.)

	Total Development	per Acre	per Unit	per Capita
Summerset (Phase 1) Construction Phase	24 Million	750,000	120,600	60,300
Cranberry Heights Construction Phase	6.2 Million	23,000	25,400	6,900
Summerset (Phase 1) Housing Construction	80 Million	2.5 Million	402,000	201,000
Cranberry Heights Housing Construction	110 Million	407,500	450,800	121,800

Analysis of On-going Emissions
(lbs. of CO_2 E. per Year)

Residential Use Phase	Total Development	per Unit	per Capita
Summerset (Phase 1) Utility Consumption	9.4 Million	47,200	23,600
Cranberry Heights Utility Consumption	19 Million	77,400	21,000
Summerset (Phase 1) Vehicle Usage	3.3 Million	16,600	8,300
Cranberry Heights Vehicle Usage	9.7 Million	40,000	10,800

Discussion

- Observations
- Conclusions
- Q & A

Observations

1. Construction phase emissions present a clear difference between the two developments

2. Per capita on-going emissions are comparable.

3. The on-going emissions will exceed the initial emissions in 8 years for Summerset (Phase 1), and 4 years for Cranberry Heights

Conclusion

- The on-going emissions from the residential use phase quickly exceed those of the initial housing and construction phases for both developments.

- In the long-run, on a per capita basis Summerset (Phase 1) and Cranberry Heights are comparable at mitigating GHG.

- These results only reflect these two developments. Future case studies are needed before any wide conclusions can be drawn.

Acknowledgements

- Business of Brownfields Conference organizers
- Carnegie Mellon University – Green Design Institute & Western Pennsylvania Brownfields Center
- Deb Lange, Executive Director, Steinbrenner Institute for Environmental Education and Research (SEER), Carnegie Mellon University
- Chris Hendrickson, Professor, Dept. of Civil and Environmental Engineering, Carnegie Mellon University
- Summerset at Frick Park Developer (The Rubinoff Company) and Engineers (GAI Consultants)
- Cranberry Township Planning Office
- US EPA Training, Research and Technology Assistance Grant EPA-560-F-08-290

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- Economic Input-Output Life Cycle Assessment (EIOLCA). Carnegie Mellon University Green Design Institute (2009). US Dept of Commerce 2002 Model of the LCA tool. http://www.eiolca.net.
- Figure 1 is taken from Google Maps (November, 2010): http://maps.google.com/maps?hl=en&tab=wl
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Questions