Scenario Planning and Visioning: I-PLACE3S

Webinar 3 of an 8-part TMIP Webinar series on land use forecasting methods.

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Land Use Forecasting Webinar Series

- The Evolving State of the Practice
- Land Use Theory and Data
- Scenario Planning and Visioning (I-PLACE3S)
- Spatial Input-Output Frameworks (PECAS)
- Dynamic Microsimulation (UrbanSim)
- Modeling Real Estate Demand
- Modeling Real Estate Supply
- Scenario Planning and Visualization

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Objectives for this Webinar

- Provide an overview of a leading example of a scenario planning tool: I-PLACE3S
- Explain its background, design, system architecture, and usage: its 'anatomy'
- Examine how it has been used in land use and transportation planning
- Assess its key strengths and weaknesses

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1 I-PLACE3S Overview Background

a. Theoretical Basis
b. Software Implementation
c. Data Inputs and Outputs

2. Anatomy of the Model
3. Application in PracticeAssessment

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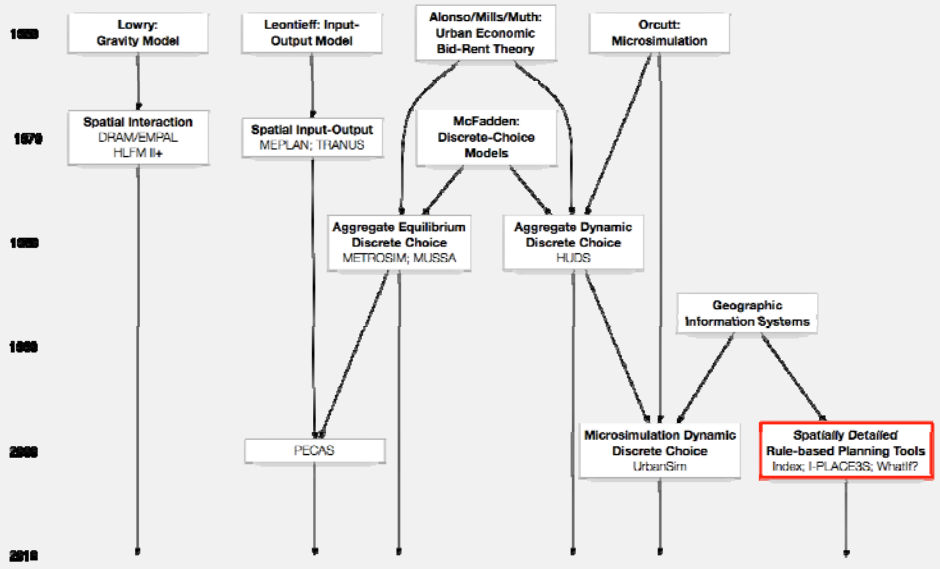
Evolution of Land Use Model Frameworks



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Scenario Planning and Sketch Planning Tools

- While this seminar focuses on I-PLACE3S as a specific example of a scenario planning tool, there are others that have similarities:
- Smart Growth Index (http://www.crit.com/)
- MetroQuest (http://www.metroquest.com/)
- RapidFire (http://www.calthorpe.com/scenario_modeling_tools)
- EnvisionTomorrow (http://frego.com/projects/envisiontomorrow.html)
- Uplan (http://ice.ucdavis.edu/project/uplan)
- WhatIf? (http://www.whatifinc.biz/)

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Basis of I-PLACE3S: Scenario Planning

- **Origins of Scenario Planning**
  - A scenario is ‘‘an internally consistent view of what the future might turn out to be—not a forecast, but one possible future outcome’’ (Porter 1985)
  - Scenario planning has precursors in the history of military and business strategic planning (Ringland, 1998). Rand corporation played significant role in the development of methodology
  - In transportation planning, scenario planning contrasts with practice of developing one baseline land use forecast, and using it in all transportation alternatives analyses
  - Scenario planning involves developing a base case scenario and using it as a base of comparison for a modest number of alternatives
  - Indicators and benchmarks used to compare and assess alternatives
  - Goal is to reach consensus among stakeholders on a preferred alternative

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Land Use - Transportation Scenario Planning Projects

Source: Bartholomew, K. 2006

Note: only a small subset of these used I-PLACE3S, mostly on West Coast

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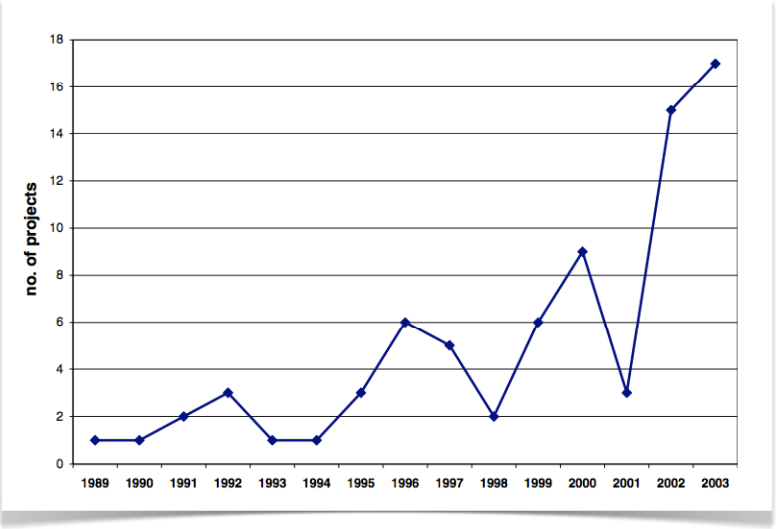
Land Use - Transportation Scenario Planning Projects



Source: Bartholomew, K. 2006

Note: only a small subset of these used I-PLACE3S, mostly on West Coast

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I-PLACE3S Background

- **PLA**nning for **C**ommunity **E**nergy, **E**conomic and **E**nvironmental **S**ustainability (PLACE3S)
- PLACE3S:
  - The original PLACE3S software application was developed in the public domain by Parsons Brinckerhoff, Fregonese Calthorpe Associates, and Space Imaging, in collaboration with ESRI.
  - Numerous additional funders, including U.S. Department of Energy, Sacramento Association of Governments (SACOG), Association of Bay Area Governments (ABAG), and others.
- I-PLACE3S:
  - In 2002, California Energy Commission commissioned EcoInteractive to convert PLACE3S to an Internet platform; PLACE3S is no longer maintained
  - California Energy Commission maintains I-PLACE3S, EcoInterative provides technical support
  - It is a scenario planning tool to visualize scenarios and policy impacts
  - It provides a web-based platform from which to communicate ideas, store data, and analyze potential outcomes

Sources for this Webinar are mainly: PLACE3S Documentation (1996), I-PLACE3S Documentation (2010), Presentation materials from Sacramento Association of Governments (SACOG)

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I-PLACE3S Projects and Scenarios

- In I-PLACE3S, each analysis is known as a 'project.' Creating scenarios for a project and running I-PLACE3S involves the following steps:
  - Data preparation
  - Define Place Types
  - Define a project and alternative
  - Apply Place Types to scenarios
  - Compare outcomes

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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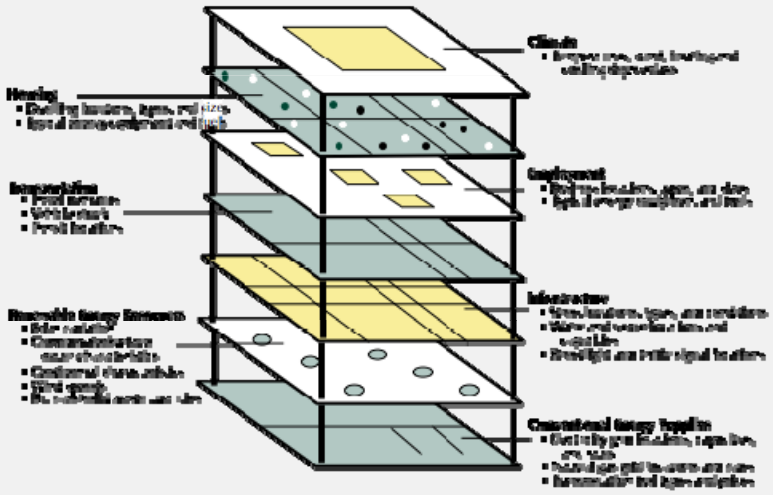
I-PLACE3S Inputs: Data Requirements



Source: PLACE3S Documentation

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I-PLACE3S Outputs: Indicators to Compare Scenarios

- Total jobs and dwelling units
- Density by land use type and mix of uses
- Change in vehicle mile traveled and vehicle trips
- Change in walk/bike and transit mode shares
- Building GHG emissions
- Building energy consumption
- Economic feasibility (Return on Investment)
- Mobile source air emissions (from regional travel model)

Source: SACOG

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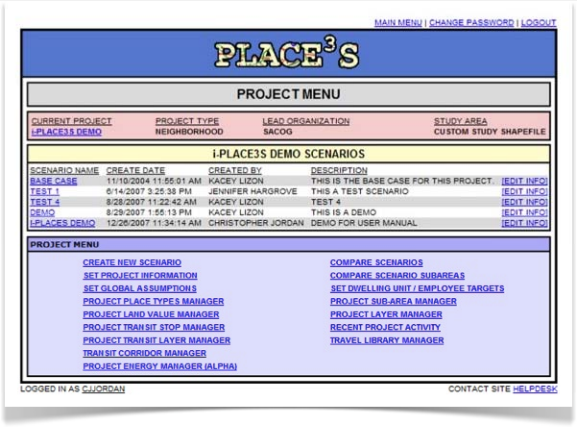
I-PLACE3S Online Access and Demo

http://places.energy.ca.gov



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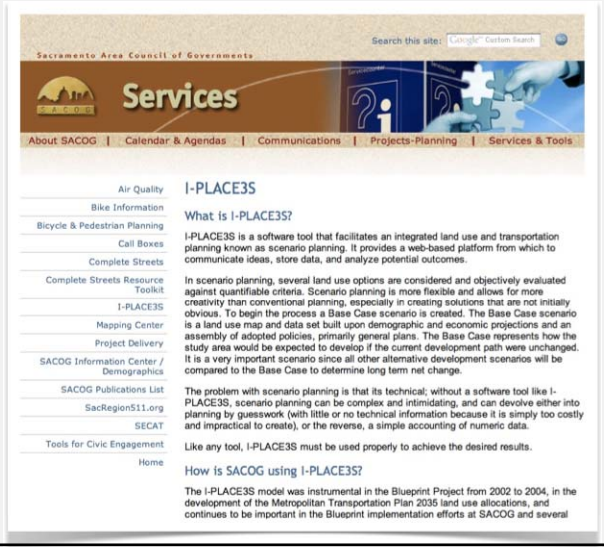
SACOG I-PLACE3S Homepage

http://www.sacog.org/services/I-PLACE3S/



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I-PLACE3S Web-Platform Development

http://www.ecointeractive.com

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I-PLACE3S Supports Land Use Planning

- Regional Government Needs
  - Long-range transportation planning
  - Long-range growth planning - Job and housing allocations
- Local Government Needs
  - Align general plans with regional plan
  - Near-term planning - approve new development projects

Source: EcoInteractive, Inc

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1. I-PLACE3S Overview
2. **Anatomy of the System**
   a. Software Architecture
   b. Community Engagement Process
   c. Place Types and Other Assumptions
   d. Usage in 4Ds Travel Model Post-Processing
3. Application in PracticeAssessment

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I-PLACES Web-based Platform: Architecture

- Web servers and database servers are hosted offsite at a co-location facility
- Load balancing distributes web requests and database accesses
- Web-based mapping based on ESRI's ArcIMS, using ArcSDE
- The database (DBMS) back-end is Oracle
- Calculations of indicators done principally in the DBMS using stored procedures an triggers

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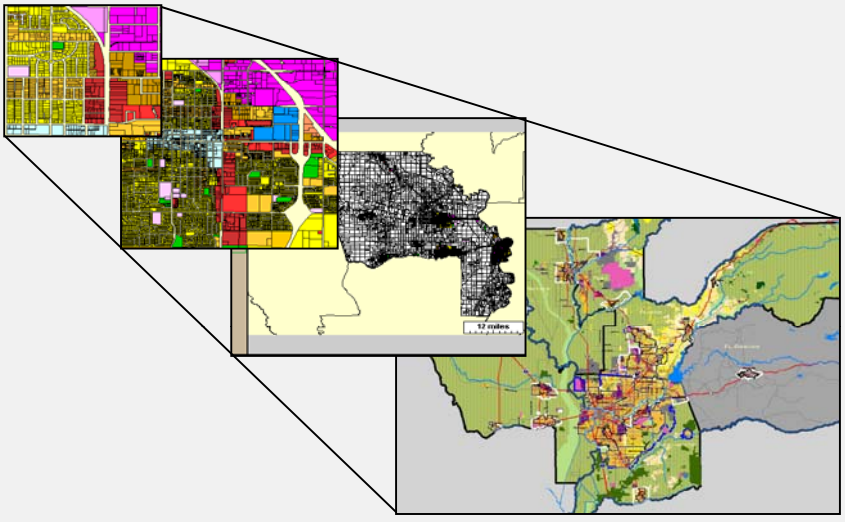
Geographic Flexibility: Neighborhood to Region-level



Source: SACOG

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I-PLACE3S: Community Engagement Process

Source: SACOG

"Place Types" are the Building Blocks

RESIDENTIAL BUILDING TYPES

1	Rural Residential			2	1	–	Rural residential includes very large lot residential (1 acre per lot).
2	Large Lot Single Family Residential			1	4	–	Arden Park has mainly large lots in the ½ to 1/3 acre size. Gardenland (South Natomas) has grid-streets with 1 acre lots and small houses.
3	Medium Lot Single Family Residential			2	6	–	Standard single family lot of 52x100 min. Allows cul-de-sacs or grid pattern, w/cul-de-sac subdivisions at low end of range. Curtis Park at high end of range.
4	Small Lot Single Family Residential			2	12	–	Small lot subdivisions: Villa Palazzo in Pocket (3,500 sqft lots), standard lots in Laguna West and some low density suburban garden apartments.
5(O)	Townhouse (Owner)			3	15	–	Metro Square in midtown is detached townhouse project at approx. 20 DU/ac. Most standard 2-story apts w/ surface parking are in this range.
5(R)	Townhouse (Rental)						
6(O)	Low-Rise Condos (Owner)			2	24	–	2+ story attached units with structured parking (e.g., tuck-under).
6(R)	Low-Rise Apartments (Rental)						
7(O)	Mid-Rise Condos (Owner)			3	35	–	3 story mid-level development. Less space dedicated to landscaping; more frontage on street.
7(R)	Mid-Rise Apartments (Rental)						
8(O)	High-Rise Condos (Owner)			6	66	–	6 story development with structured parking. Buildings include elevators, interior courtyards, and hallways.
8(R)	High-Rise Apartments (Rental)						
9(O)	Urban Condos (Owner)			10	105	–	10 story urban development. Buildings may include a health facility, door man, etc.
9(R)	Urban Apartments (Rental)						

- User-Defined Place Types
- Define allowed land uses
- Can include land uses that do not yet exist in codes (e.g. mixed use)
- Attributes Set by User:
  - Dwelling units per acre
  - Employees per acre
  - % of use in each sector (residential, retail, office, industrial, public, other)
  - Floor Area Ratio

Source: PLACE3S Documentation

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Defining Place Types: Detailed Assumptions

- Place Type Name
- Affordable Housing
- Transit Friendliness
- Pedestrian Friendliness
- Default Percent Development
- Image
- Place Type Legend
- Mixed Use (yes/no)
- % of Place Type by 6 LU Sectors
- Square Footage by LU Sector
- Parking Ratios per 1000 Sqft or per dwelling
- Parking Types Distribution (levels)
- Landscaping/Setback %
- Residential Type
- Avg. Lot Size
- Maximum Height
- Number of Bedrooms
- Accessory Units
- Existing Units Accessory Ratio
- New Accessory Ratio

Source: I-PLACE3S Documentation

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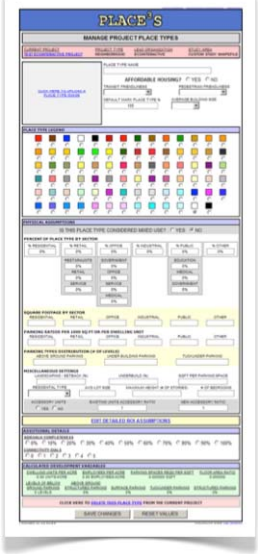

Source: I-PLACE3S Documentation

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Place Types Can Be Generated from General Plan

General Plan Land Uses → I-Place3s Land Uses

Land Use and Urban Form Designation	Guidelines: Building Height (Number of Stories)	Standards: Minimum Density (dwelling units per acre)	Standards: Maximum Density (dwelling units per acre)	Standards: Minimum Floor Area Ratio (FAR)
Neighborhoods				
Rural Residential (See Page 2-40)	1-3	0.25	3.0	N/A
Suburban Neighborhood Low Density (See Page 2-44)	1-3	3.0	8.0	N/A
Suburban Neighborhood Medium Density (See Page 2-44)	1-3	7.0	17.0	N/A
Suburban Neighborhood High Density (See Page 2-44)	1-3	15.0	30.0	0.35
Traditional Neighborhood Low Density (See Page 2-48)	1-3	3.0	8.0	N/A
Traditional Neighborhood Medium Density	1-3	8.0	21.0	N/A

PLACE TYPES — PLACE TYPE MARKING RULES

PLACE TYPE NAME	DU / ACRE	EMP / ACRE
1. RURAL RESIDENTIAL	1.00000	0.00000
2. LARGE LOT SINGLE FAMILY RESIDENTIAL	4.00000	0.00000
3. MEDIUM LOT SINGLE FAMILY RESIDENTIAL	6.00000	0.00000
4. SMALL LOT SINGLE FAMILY RESIDENTIAL	12.00000	0.00000
5(O). TOWNHOUSE (OWNER)	15.00000	0.00000
5(R). TOWNHOUSE (RENTAL)	15.00000	0.00000
6(O). LOW-RISE CONDOS (OWNER)	23.59500	0.00000
6(R). LOW-RISE APARTMENTS (RENTAL)	24.55200	0.00000
7(O). MID-RISE CONDOS (OWNER)	35.41794	0.00000
7(R). MID-RISE APARTMENTS (RENTALS)	35.28486	0.00000
8(O). HIGH-RISE CONDOS (OWNER)	69.01934	0.00000
8(R). HIGH-RISE APARTMENTS (RENTAL)	68.64000	0.00000
9(O). URBAN CONDOS (OWNER)	105.38710	0.00000
9(R). URBAN APARTMENTS (RENTAL)	105.68656	0.00000
10. MID-RISE OFFICE	0.00000	54.15769
11. HIGH-RISE OFFICE	0.00000	154.62889
12. COMMUNITY/NEIGHBORHOOD RETAIL	0.00000	47.39328
13. HOTEL	0.00000	74.50534
14(O). HORIZONTAL MIXED USE	6.00000	33.60000
15(O). LIVE/WORK (OWNER)	22.47015	22.47015
15(R). LIVE/WORK (RENTAL)	23.39716	23.39716
16(O). MIXED USE RESIDENTIAL FOCUS MID-RISE (OWNER)	23.28871	39.62556
16(R). MIXED USE RESIDENTIAL FOCUS MID-RISE (RENTAL)	23.28871	39.62556
17(O). MIXED USE RESIDENTIAL FOCUS HIGH-RISE (OWNER)	85.10470	83.14075
17(R). MIXED USE RESIDENTIAL FOCUS HIGH-RISE		

Source: I-PLACE3S Documentation

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Stakeholders Create Scenarios Using Place Types

Stakeholders assign place types to map: must match target population and employment

Source: SACOG

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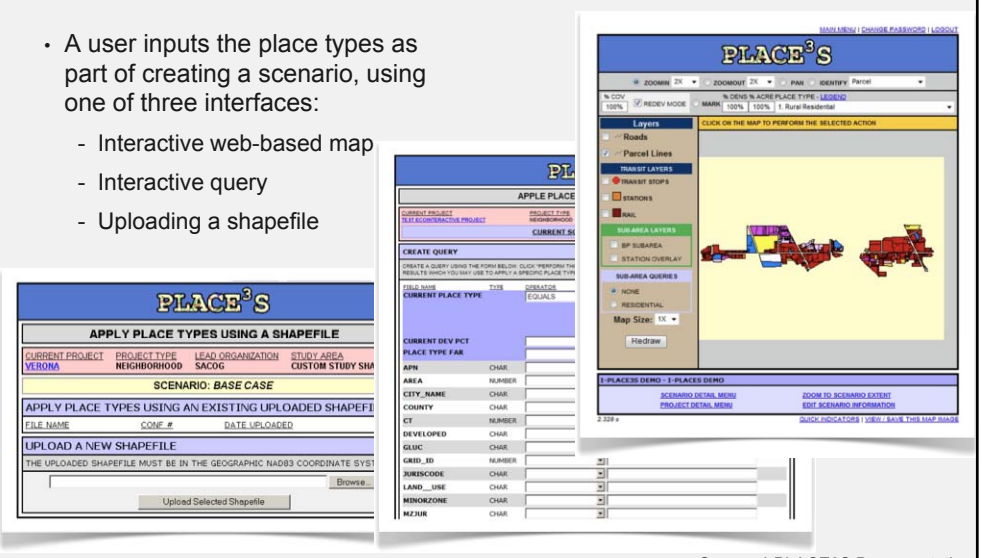
I-PLACE3S Scenario Analysis

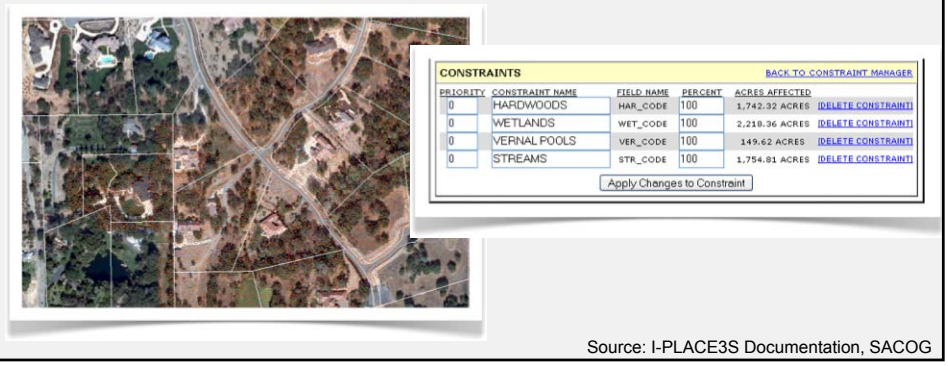
- A user inputs the place types as part of creating a scenario, using one of three interfaces:
  - Interactive web-based map
  - Interactive query
  - Uploading a shapefile



Source: I-PLACE3S Documentation

I-PLACE3S Constraint Manager

- I-PLACE3S has the ability to limit, or constrain, development on parcels.
- The user must create a shapefile containing the constraints, and upload it
- The constraint shapefile is overlaid on parcels to apply user specified rules that limit the development yield
- Constraints are specified for each scenario



Source: I-PLACE3S Documentation, SACOG

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I-PLACE3S: Issues Explored in Scenarios

- Amounts of growth
- Balance of land uses
- Mix of new housing units
- Balance of infill/redevelopment and greenfield
- Location of land uses and transportation facilities
- Density of new development
- Location of development re:resource lands
- Reality testing: rate of return analysis

Source: SACOG

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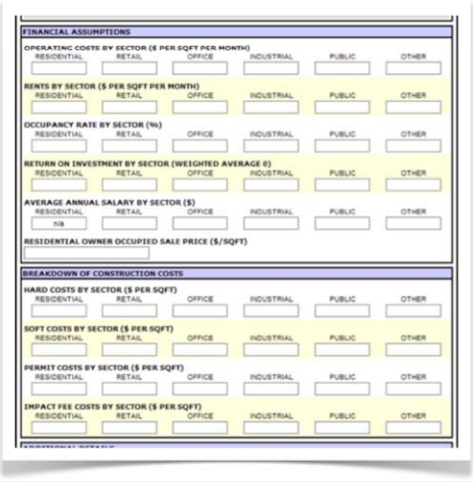
I-PLACE3S: Calculation of Return on Investment (ROI)

- Assumptions input on costs and income
- Total Cost = Land Cost + Structure Cost + New Construction + Parking Construction
- Total Income = Residential Sale Price or Yearly Rents - Yearly Operating Cost
- Margin = Total Income - Total Cost
- ROI = Margin / Total Cost



Source: I-PLACE3S Documentation

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I-PLACE3S: Calculation of Return on Investment

PARCEL STATISTICS	
Development Type:	5(R). TOWNHOUSE (RENTAL)
Development Type Pct:	100%
Land Area:	9,969 SQ FT
Building Total Floor Area:	4,119 SQ FT
Building Footprint:	1,373 SQ FT
Yearly Income:	$59,317
Yearly Operating Costs:	$17,301
Building Construction Costs:	$389,266
Parking Construction Costs:	$34,327
Total Construction Costs:	$483,404
Yearly Net Operating Income:	$42,016
Land Value:	$59,811
Calculated ROI:	9%
Weighted ROI:	0%

Source: I-PLACE3S Documentation

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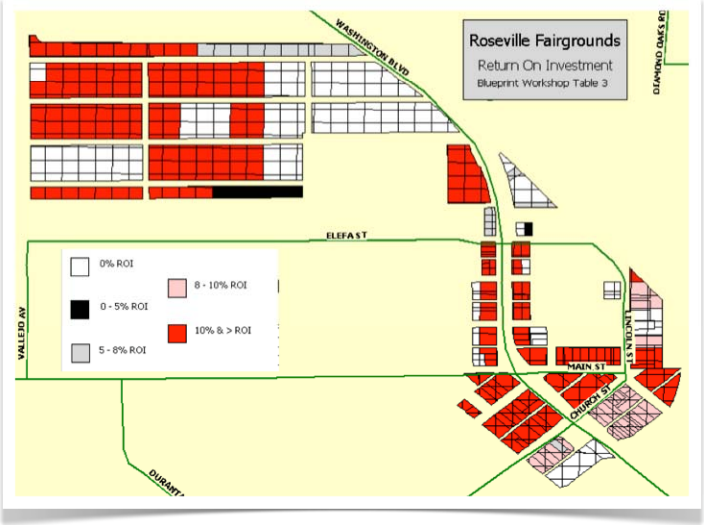
I-PLACE3S: Calculation of Return on Investment



Source: SACOG

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1. I-PLACE3S overviewAnatomy of the System
2. **Application in Practice**
3. Assessment

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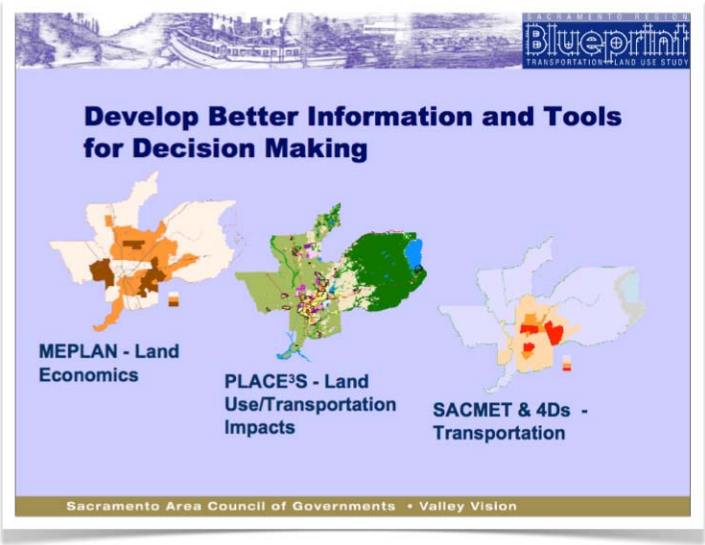
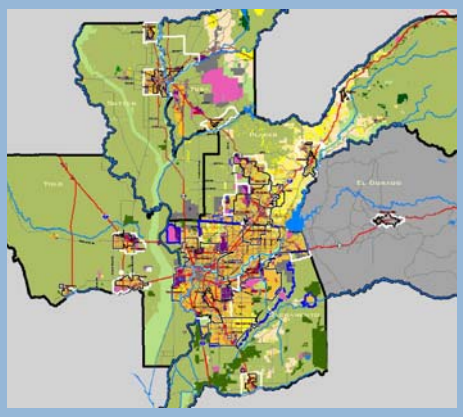
Case Study: SACOG Blueprint Project



Source: SACOG

Regional Blueprint Land Use Scenarios



Sacramento Area Council of Governments

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SACOG Blueprint Project: Overview

- Regional (6 county) analyses of growth effects
- Broad partnership building
  - Employers, developers and investors, press, special interests, citizens
- Public workshops on neighborhood issues
- County-level analyses
- Annual summits – 1000+ attendees
- Regional deployment through member cities and counties

Source: SACOG

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SACOG Blueprint Project: Overview

- Engages the public & local government in crafting a vision for future growth
- Held workshops in neighborhoods, cities, and counties
- Created & compared future growth scenarios
  - Base case - continue recent development patterns
  - Smart growth scenarios - developed by planners and workshop participants
- I-PLACE3S allowed users to quickly analyze the results of each scenario for
  - Housing, employment, reinvestment, amount of urbanized land, preservation of agricultural land, growth near transit, vehicle miles traveled …
- I-PLACE3S outputs were used in SACMET, the SACOG 4-Step Travel Model
- I-PLACE3S outputs used to generate data for 4D adjustments of Travel Model

Source: SACOG

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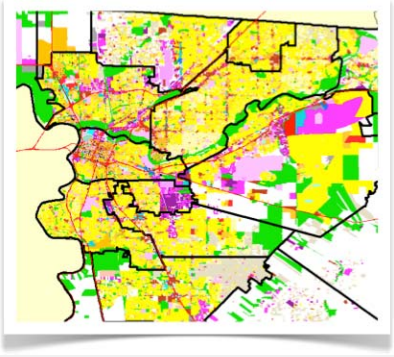
Land Use Assumptions Export to Travel Model

I-PLACE3S → Excel File



A	B	C	D	E	F	G	H	I
EXISTING CONDITIONS - JANUARY 2007								
TAZ	TOTAL DWELLING UNITS	ATTACHED DWELLING UNITS	DETACHED DWELLING UNITS	TOTAL EMPLOYEES	RETAIL JOBS	OFFICE JOBS	INDUSTRIAL JOBS	PUBLIC JOBS
1043	395	0	395	3,378	294	2,005	1,079	0
1119	0	0	0	0	0	0	0	0
1120	0	0	0	0	0	0	0	0
1121	0	0	0	0	0	0	0	0
1122	0	0	0	4,044	38	3,951	55	0
1123	1,323	0	1,323	1,425	15	1,336	0	0
1124	0	0	0	4,364	235	2,187	1,942	0
1138	0	0	0	0	0	0	0	0
1142	0	0	0	0	0	0	0	0
116	0	0	0	289	0	0	289	0
1160	0	0	0	0	0	0	0	0

Source: SACOG

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SACOG Blueprint Project: 4D Adjustment

- Blueprint Project Context
  - SACOG initiated a public visioning process for the long-term future of the Sacramento Region
  - Smart Growth policies were prominently featured in the debate
  - However, the regional model (SACMET) was insensitive to 4D characteristics
  - The model needed to be augmented to enable quantitative forecasts of the effects of smart growth policies in different scenarios
- Approach Used
  - 4D adjustments were computed as elasticities (each % change in neighborhood characteristics resulted in a certain % change in travel behavior)
  - % changes based on differences from a Base Case
  - These adjustments were applied to outputs from the SACMET model

Source: Fehr & Peers

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What are the 4Ds?

- National research has found that certain characteristics of the built environment tend affect travel behavior in predictable ways. These characteristics are:
  - Density in terms of dwelling units or jobs per acre
  - Diversity of land uses within any given area
  - Design of the pedestrian and bicycling environment
  - Destinations; proximity to regional activity centers

Source: Fehr & Peers

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Why are the 4Ds important?

Because they affect per-capita auto use

Environmental Characteristic	Elasticity VT Per Capita	Elasticity VMT per Capita
Density	4% to 12%	1% to 17%
Diversity	1% to 11%	1% to 13%
Design	2% to 5%	2% to 13%
Destinations	5% to 29%	20% to 51%

Sources: 4D National Syntheses, Twin Cities, Sacramento, Location Efficiency

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"Blind Spots" in Conventional Travel Models

- Walking Trips
  - Walking trips must use road links, and only roads big enough to be in the traffic model
  - Sidewalk completeness and other aspects of sidewalk condition (shade, aesthetics, etc.) are ignored
  - Intra-zonal and adjacent-TAZ trips (the most important for walk mode) are handled very abstractly
- Land Use
  - No consideration is given to the distances between land uses within a given TAZ
  - Interactions between different non-residential land uses (e.g. offices and restaurants) not well represented
  - Density is ignored (a TAZ with a dense development in one corner is treated the same as a TAZ with the same population spread evenly throughout its area)

Source: Fehr & Peers

SACOG Blueprint Project: Models

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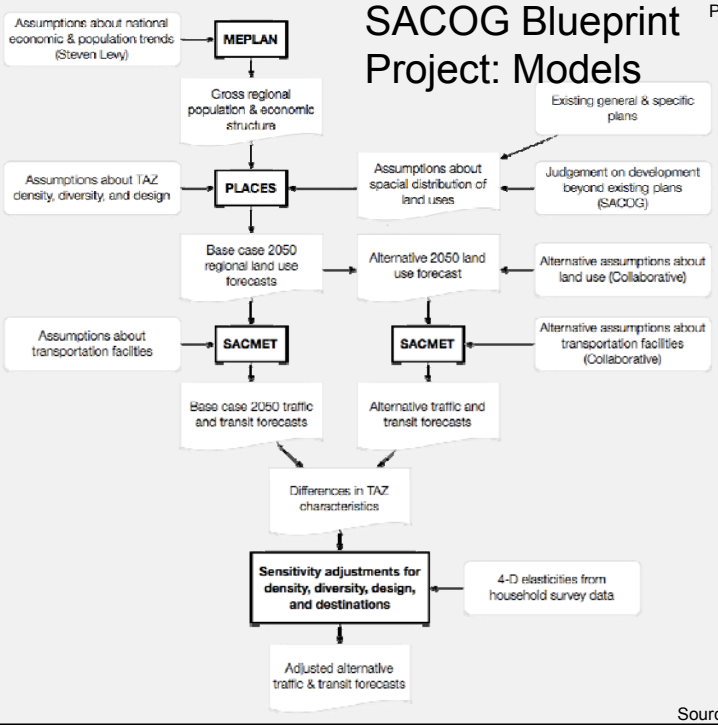

Source: SACOG

4D Adjustment Methodology

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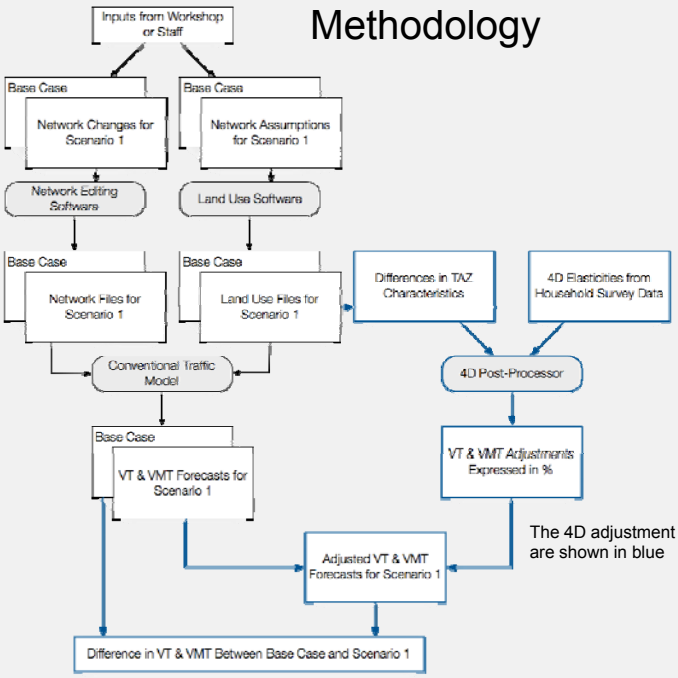

The 4D adjustment components are shown in blue

Source: Fehr & Peers

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4D Adjustment Methodology: Data Sources

- VT & VMT data came from a large (4,000 HH) travel diary survey
- Households, jobs, and developed acres came from a parcel database (400,000+ parcels)
- Sidewalk coverage and route directness came from aerial photographs

Source: Fehr & Peers

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4D Adjustment Methodology: Regression Analysis

Different formulas were used for different trip purposes

Some values were not statistically significant

4D Elasticities from Household Surveys		Net Res. Density	Net Emp. Density	Job-HH Diversity	Jobmix Diversity	Index Design	HBW Destinations	Non-HBW Destinations
VT	HBO	-0.119		-0.044		-0.039		-0.041
	HBW	-0.117		-0.059		0.000	-0.375	
	NHB		-0.339		-0.0462	0.000		-0.822
VMT	HBO	-0.133		-0.16		-0.030		-1.405
	HBW	-0.238		-0.26		0.000	-1.234	
	NHB		-0.444		-0.459	0.000		-1.318

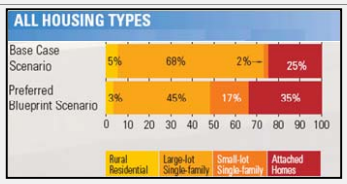
HBW was the least elastic

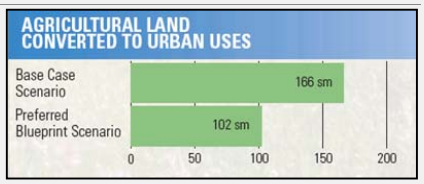
NHB was the most elastic

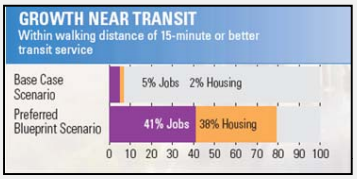
Source: Fehr & Peers

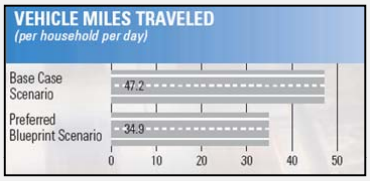
P. Waddell, 2011

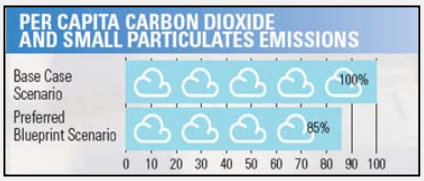
SACOG Blueprint Project: Smart Growth Indicators

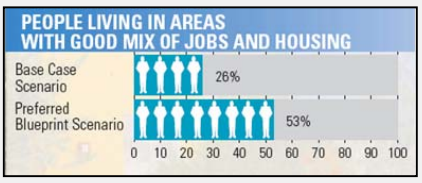












"It is my belief that global warming is the defining issue for humankind in the 21st century." Ron Sims, King County Executive (currently Deputy Secretary of U.S. Department of Housing and Urban Development)

I-PLACE3S Case Study

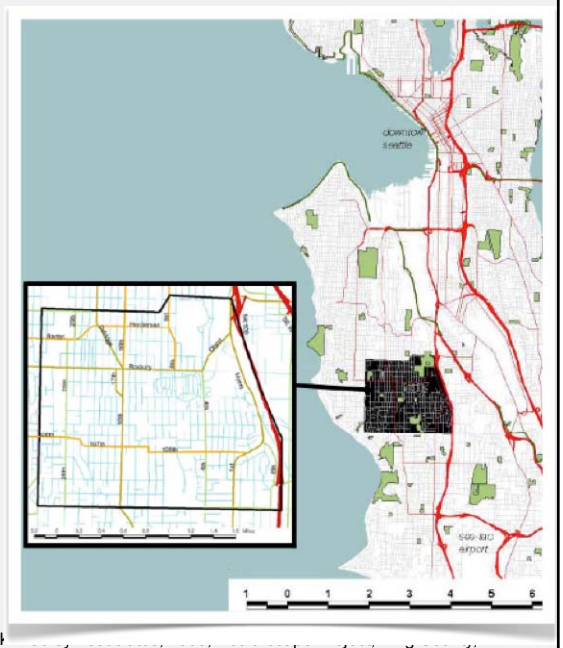
White Center, King County, WA

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

P. Waddell, 2010

White Center

Geographical context



Source: Lawrence Frank & Co, Inc., SACOG, Mark
WA

P. Waddell, 2011

Scenarios Tested

- The Buildout Scenario, which assumed redevelopment of all the redevelopable parcels at the maximum zoned capacity
- The Interim Buildout Scenario assumed maximum buildout of some of the redevelopable parcels in the study area
- The TOD-only Scenario assumed redevelopment of a single parcel into a Transit-Oriented Development (TOD)

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

P. Waddell, 2011

Study Area: SW 98th Street

Proposed pedestrian connection shown in green; the blue parcel is the potential TOD site tested in the 'TOD only' scenario.

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Case Study Place Types

	01 - (O). TOWNHOUSE (OWNER)	3	15.00	0.00
	02 - (R). TOWNHOUSE (RENTAL)	3	15.00	0.00
	03 - (O). LOW-RISE CONDOS (OWNER)	2	23.60	0.00
	04 - (O). MID-RISE CONDOS (OWNER)	3	35.42	0.00
	05 - (R). MID-RISE APARTMENTS (RENTALS)	3	35.28	0.00
	06 - (O). HIGH-RISE CONDOS (OWNER)	6	69.02	0.00
	07 - **MID-RISE HOUSING (OWN & RENT, R-24)	3	41.82	0.00
	08 - **MID-RISE MIXED USE (CBSO)	3	34.16	64.06
	09 - **MID-RISE MIXED USE PED CORRIDOR (CBSO)	4.5	81.68	65.63
	10 - *BANK (CBSO)	2	0.00	41.88
	11 - *CONV STORE W/GAS (CBSO)	1	0.00	31.21
	12 - *DUPLEX (R-18, R-24)	2	13.61	0.00
	13 - *INDOOR ACTIVITY CENTER	1	0.00	10.89
	14 - *LOW-RISE APARTMENTS (RENT, LIVE/WORK, R-18)	1	21.51	21.07
	15 - *LOW-RISE APARTMENTS (RENT, SMALLLOT, R-18)	2	33.22	0.00
	16 - *LOW-RISE APARTMENTS (RENT, LARGELOT, R-18)	2	33.22	0.00
	17 - *OFFICE BLDG (CBSO, LARGELOT)	1	0.00	44.55
	18 - *OFFICE BLDG (CBSO, SMALLLOT)	1	0.00	44.55
	19 - *PARK/OPEN SPACE (R-6, R-18)	0	0.00	0.00
	20 - *PARKING LOT (CBSO)	0	0.00	0.00
	21 - *RESTAURANT	1	0.00	35.00
	22 - *RETAIL STORE (CBSO)	2	5.75	52.53
	23 - *ROW/ROAD (R-18)	0	0.00	0.00
	24 - *SINGLE FAMILY HOME (LARGELOT >5000SF; R-6, R-24)	2	5.73	0.00
	25 - *SINGLE FAMILY HOME (SMALLLOT 5000SF OR LESS/R-18)	2	18.01	0.00
	26 - *VACANT	0	0.00	0.00
	27 - *WAREHOUSE/LIGHT INDUSTRIAL	1	0.00	30.04
	28 - COMMUNITY/NEIGHBORHOOD RETAIL	1	0.00	47.39
	29 - HOTEL	8	0.00	16.13
	30 - INDUSTRIAL	1	0.00	25.02
	31 - PUBLIC/CIVIC/EDUCATION	2	0.00	19.15
	34 - TOD WHITE CENTER	5	60.61	37.61
	35 - FAST FOOD		0.00	0.00

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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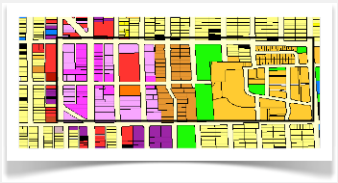
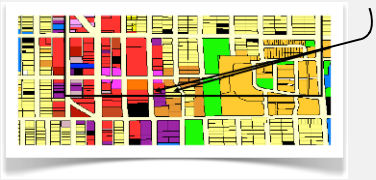
Scenario Possibilities

Base Case Scenario

Full Buildout

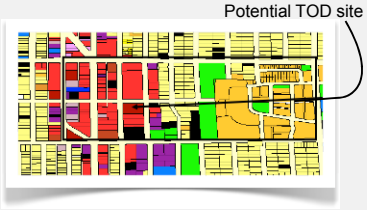


Redeveloped residential parcels



Interim Buildout

Potential TOD site



TOD-Only Scenario

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Changes in Population and Employment

	Total Employee Change	Total Employees	Employers per Acre	Total Dwelling Unit Change	Total Dwelling Units	Dwelling Units per Acre
Existing Conditions	0	827	27.72	0	777	25.24
TOD-Only	+4	831	28.36	+53	830	26.49
Interim Buildout	+31	858	33.32	+448	1,225	35.11
Full Buildout	+1,017	1,844	101.25	+1,724	2,501	58.97

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Totals per Dwelling Unit: Emissions, Car Trips & Miles

	CO_2 (kg)	NOX (grams)	HC (grams)	CO (grams)	Car Vehicle Trips	Car Vehicle Miles
Existing Conditions	4.17	47.62	51.69	580	9.29	48.82
TOD-Only	4.17	47.61	51.68	579.71	9.29	48.82
Interim Buildout	4.04	47.1	51.12	573.64	9.21	48.31
Full Buildout	13.94	46.7	50.61	569.82	9.08	47.85

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Whole Study Area Totals: Emissions, Car Trips & Miles

	CO_2 (kg)	NOX (grams)	HC (grams)	CO (grams)	Car Vehicle Trips	Car Vehicle Miles
Existing Conditions	10,652	35,792	38,851	435,976	6,984	36,695
TOD-Only	11,400	38,287	41,562	466,238	7,470	39,263
Interim Buildout	16,104	54,008	58,616	657,815	10,562	55,397
Full Buildout	34,505	115,622	125,305	1,410,812	22,474	118,472

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Total and per DU Transit Person Trips / Miles

	Transit Person Trips / DU	Transit Person Miles / DU	Total Transit Person Trips	Total Transit Person Miles
Existing Conditions	1.59	12.67	1,194	9,526
TOD-Only	1.58	12.64	1,271	10,168
Interim Buildout	1.55	12.47	1,782	14,297
Full Buildout	1.57	12.99	3,881	32,156

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Total and per DU Walk / Bike Trips and Miles

	Walk Bike Trips / DU	Walk Bike Miles / DU	Total Walk Bike Trips	Total Walk Bike Miles
Existing Conditions	3.25	3.13	2,445	2,356
TOD-Only	3.23	3.08	2,602	2,475
Interim Buildout	3.23	2.97	3,699	3,410
Full Buildout	3.37	2.73	8,340	6,769

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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BMI and Physical Activity

	BMI / Adult	Minutes of Physical Activity / Adult
Existing Conditions	24.74	37.06
TOD-Only	24.72	37.11
Interim Buildout	24.5	38.24
Full Buildout	24.1	41.94

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Dependent Variables

- Transportation Outcomes
  - Number of Vehicle Trips
  - Vehicle Miles Traveled
  - Number of Transit Person Trips
  - Transit Person Miles Traveled
  - Number of Bike/Walk Trips
  - Bike/Walk Miles Traveled
- Climate and Air Quality Outcomes
  - Carbon Dioxide (CO2, kg)
  - Oxides of Nitrogen (NOx, g)
  - Hydrocarbons (HC, g)
  - Carbon Monoxide (CO, g)
- Physical and BMI Variables
  - Total Minutes of Vigorous + Moderate Physical Activity Per Day (VMPA)
  - Body Mass Index (BMI)

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Independent Variables

- Land Use Variables
  - Net residential density
  - Retail Floor Area Ratio (FAR)
  - Intersection Density
  - Land Use Mix
  - Access to parks, retail/fast food, and transit
- Accessibility Variables
  - Auto peak / off-peak accessibility
  - Transit peak / off-peak accessibility
- Household demographic variables
  - Number of working adults in household (0/1/2+)
  - Non-working adults in HH (0/1/2+)
  - Children in HH (0/1/2+)
  - HH income under $50K (1=yes/0=no)
  - HH income over $100K (1=yes/0=no)
  - HH fewer cars than adults (1=yes/0=no)

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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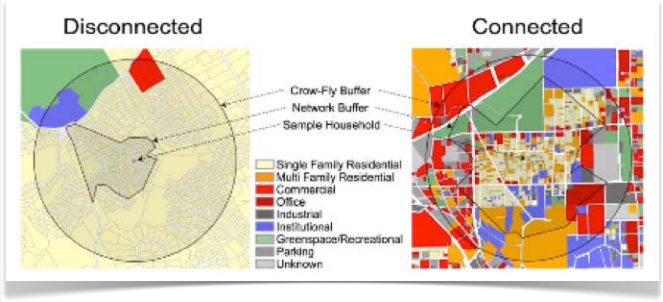
Measuring Land Use Patterns Using Network Buffers



Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Final Model for Physical Activity and BMI Outcomes

Model Type	Regression		Regression	
Dependent variable	Total Daily Minutes of Moderate & Vigorous Physical Activity LN(VMPA)*		Body Mass Index LN(BMI)*	
	Coeff.	T-stat	Coeff.	T-stat
Adults in HH (0/1/2+)	-0.0781	-2.9	--	--
Children in HH (0/1/2+)	0.0903	2.6	--	--
Adult is employed (0/1)	0.2368	5.4	--	--
HH fewer cars than adults (0/1)	0.1476	3.4	--	--
HH income under $35K (0/1)	-0.1716	-4.6	0.0341	2.7
HH income over $100K (0/1)	0.0916	2.4	-0.0265	-2.1
Intersection density	0.0311	1.1	-0.0309	-3.2
Park/recreation available in buffer	0.0965	2.1	-0.0220	-2.5
RPD - Single family units only in buffer	0.1567	2.7	-0.0140	-1.2
RPD - Mixed unit types in buffer	0.0217	4.4	-0.0331	-3.4
Retail FAR	0.4986	2.9	--	--
# Fast food parcels	--	--	0.0387	2.9
# Other retail/food parcels	--	--	0.0303	3.1
Transit accessibility measure	--	--	-0.0315	-1.6
LN(VMPA)	--	--	-0.0961	-13.0
Constant	3.9672	58.3	3.0037	92.1
R-squared (adj)	0.075		0.111	

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Final Model for Climate and Air Quality Outcomes

Dependent variable (all regression models)	CO2 (grams) Coeff.	CO2 (grams) T-stat	NOX (grams) Coeff.	NOX (grams) T-stat	HC (grams) Coeff.	HC (grams) T-stat	CO (grams) Coeff.	CO (grams) T-stat
Working adults in HH (0/1/2+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Non-working adults in HH (0/1/2+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Children in HH (0/1/2+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH income under $35K (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH income over $100K (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH fewer cars than adults (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transit weighted accessibility	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Miles to nearest bus stop squared	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Single family only in buffer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Land Use Mix	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Intersection density	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Constant	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
R-squared (adj)	[illegible]		[illegible]		[illegible]		[illegible]	

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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Final Model for Transportation Outcomes

Dependent variable (all regression models)	Car vehicle trips		Car vehicle miles		Transit person trips		Transit person miles		Walk/bike trips		Walk/bike miles	
	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat
Working adults in HH (0/1/2/3+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Non-working adults in HH (0/1/2+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Children in HH (0/1/2+)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH income under $30K (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH income over $100K (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HH fewer cars than adults (0/1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transit weighted accessibility	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--
Auto weighted accessibility	--	--	--	--	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--
Miles to nearest bus stop squared	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--
Single family only in buffer	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--	--	--
Retail FAR	--	--	--	--	--	--	--	--	[illegible]	[illegible]	[illegible]	[illegible]
Land Use Mix	[illegible]	[illegible]	[illegible]	[illegible]	--	--	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Intersection density	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
# Retail/food parcels	--	--	--	--	--	--	--	--	[illegible]	[illegible]	[illegible]	[illegible]
Park/recreation available	--	--	--	--	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--
Constant	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
R-squared (adj)	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	

Source: Lawrence Frank & Co, Inc., SACOG, Mark Bradley Associates, 2009, Healthscape Project, King County, WA

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1. I-PLACE3S overview
2. Anatomy of the System
3. Application in Practice
4. **Assessment**

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Assessment of I-PLACE3S: Strengths

- Effective tool for community engagement at scales from neighborhood to region
  - Little technical skill required for stakeholders in public workshops
  - Place types are easy for users to understand
  - Supports process of collaboratively designing scenarios and achieving consensus on preferred alternative
- Does not require high-end hardware or expensive license for user in workshops
- Works at parcel level of detail
  - Makes it easy to represent land use policies and outcomes
  - Makes it easy to aggregate results to flexible geographies
- High performance: results from neighborhood projects are very fast; even regional projects can be analyzed relatively quickly
- Extensive set of indicators to evaluate alternative scenarios
- Indicators can be extended by adding appropriate assumptions

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Assessment of I-PLACE3S: Weaknesses

- Theoretical content is fairly limited, beyond basic approach to scenario planning
- Documentation on methods used to compute indicators is lacking (the King County Healthscape report is an exception)
- Default indicators may be incorrect for a local application
- For transportation and GHG emissions indicators that do not use travel model:
  - Insensitive to changes in the transportation network, level of service, and pricing
  - Effects on congestion of different I-PLACE3S scenarios would not be considered
- For transportation and GHG emissions indicators using 4D adjustments:
  - These are post-processing adjustments of aggregate 4-step travel model, not part of the travel model - need to be properly calibrated on local data
  - No feedback from travel model to I-PLACE3S
- Economic reality testing is very limited: ROI makes strong assumptions about project revenue, prices; no attempt to model market demand or supply or prices

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I-PLACE3S Web-based Platform: Strengths

- User does not need a fast machine
  - Servers perform all calculations and graphs. User views web page to see the results
- No need to ship shapefiles and other project files to other users
- Easy to grant access to alter projects and scenario files – or limit to read access
- Secure system features encrypted communications (HTTPS)
  - Government code free and secure
  - User data secure
- Comparing scenarios is easy
  - Files are housed on a central database server
  - Simple to compare calculations and generate graphs even if the scenarios were produced by different users
- No need to download updates, new versions of software or patches
  - As features are added, changes are instantly available upon next login

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I-PLACE3S Web-based Platform: Weaknesses

- Requires a high-end Oracle database server configuration at host facility
- License costs for Oracle, ArcIMS, ArcGIS can be substantial
- Technical staffing required for database and web system maintenance and administration
- Centralized administration of users provides limited access
- Implementing models as database stored procedures does not scale well from simple indicators to complex models
- Significant computational load from using ArcGIS to do spatial analysis
- Costs per project for database storage and access
- Data requirements are extensive:
  - Parcel data, detailed employment and household data, land use plans, place types
  - Data requirements comparable to those of more comprehensive models
  - No process in place for dealing with missing or messy data

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I-PLACE3S Summary and Recommendations

- Assessment Summary
  - Provides an exemplary system for scenario planning: highly interactive and visual, useful for stakeholder engagement, quick response
  - Place types help stakeholders understand the process, but also represent strong assumptions: cities cannot dictate how many people or jobs will locate somewhere
  - Lack of modeling of demand, supply, and prices limits sensitivity and realism of the model when comparing scenarios affecting transportation and land use
- Recommendations
  - Consider use for visioning processes, while being careful to explain limits
  - Combine with a more rigorous analysis of final scenarios using more comprehensive models that include demand, supply and price component
  - Consider developing calibration methods to ensure general consistency of the I-PLACE3S results with those of the more complete model system
  - Consider transitioning to empirically-estimated models for formal planning projects

Questions and Discussion

I-PLACE3S Links:

http://places.energy.ca.gov
http://www.sacog.org/services/I-PLACE3S/
http://www.kingcounty.gov/transportation/healthscape.aspx

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