Transportation and Carbon Emissions
New Challenges in Land Use and Transportation Planning

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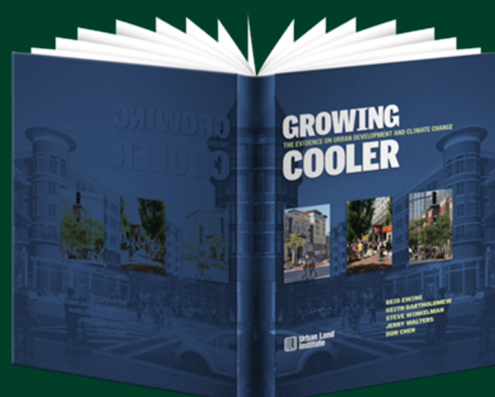
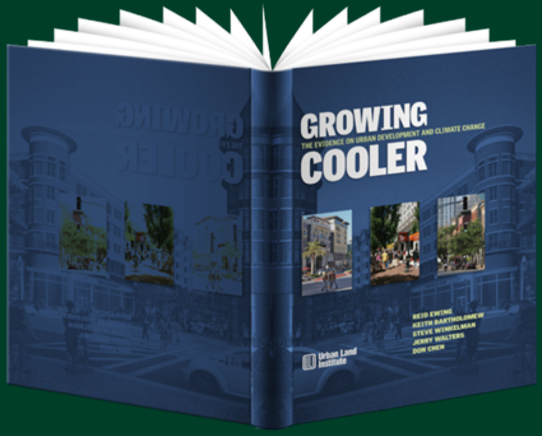
Presentation to:
RMLUI

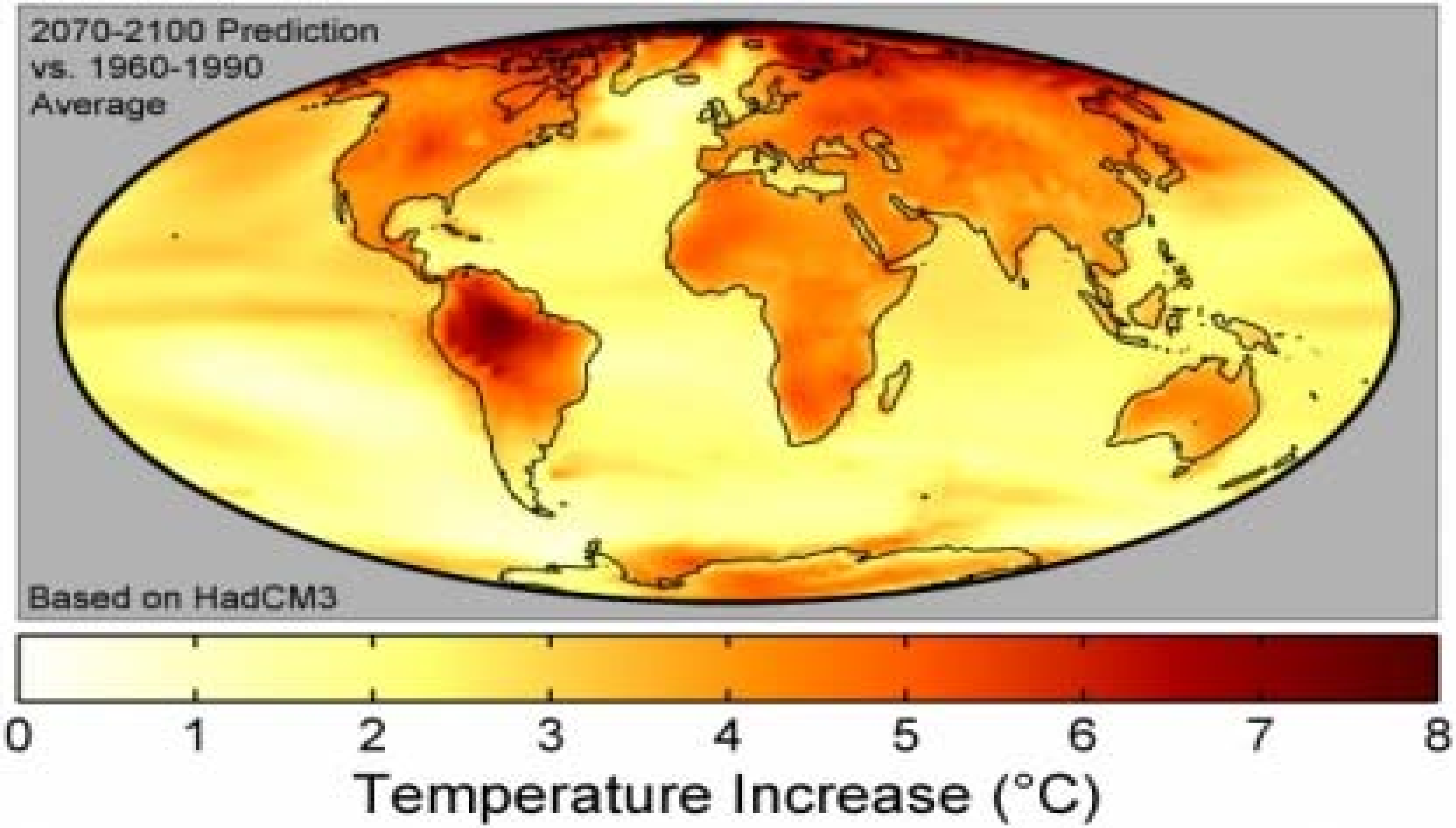


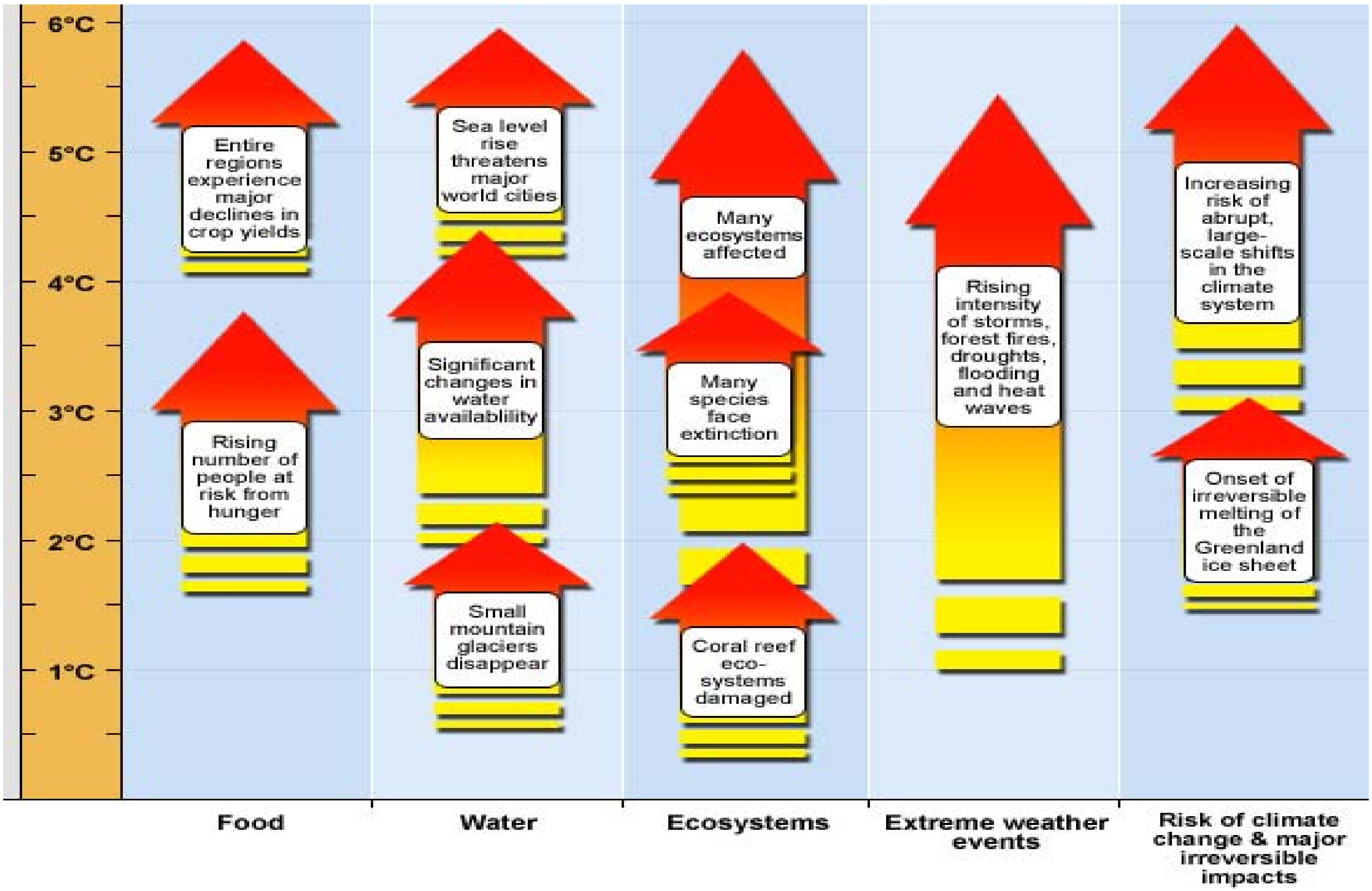
March 5, 2010

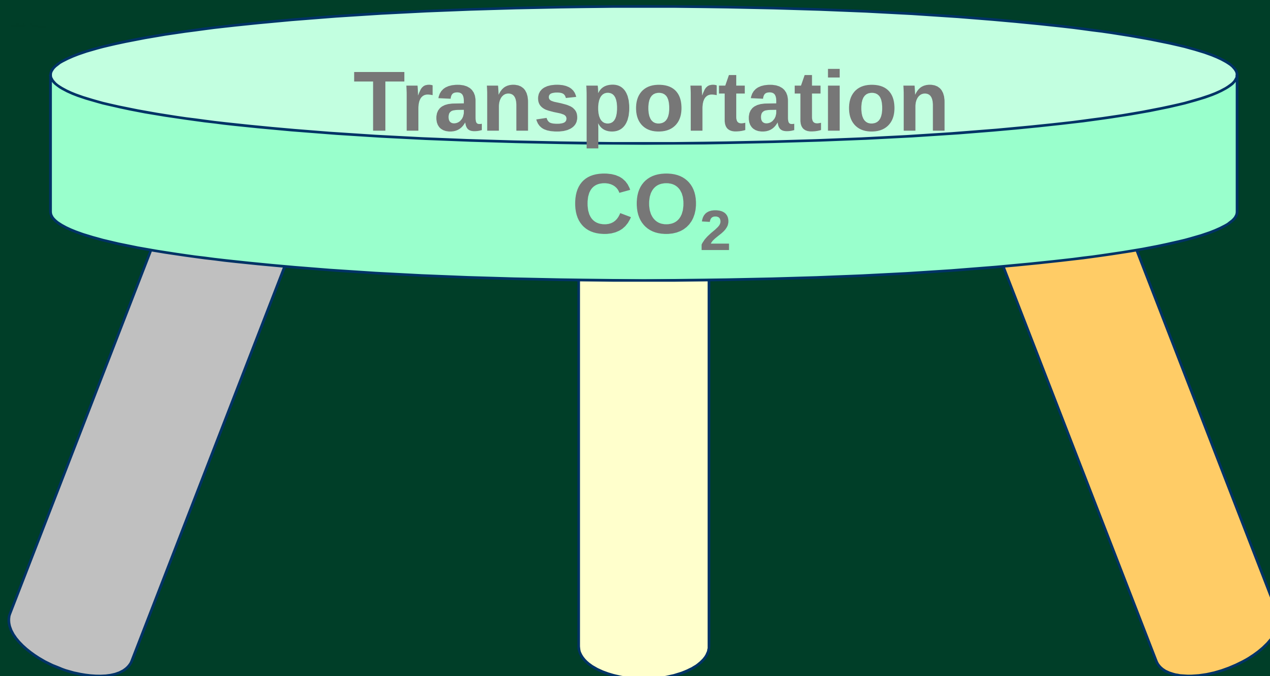
Part I – Planning Context



Global Warming Predictions



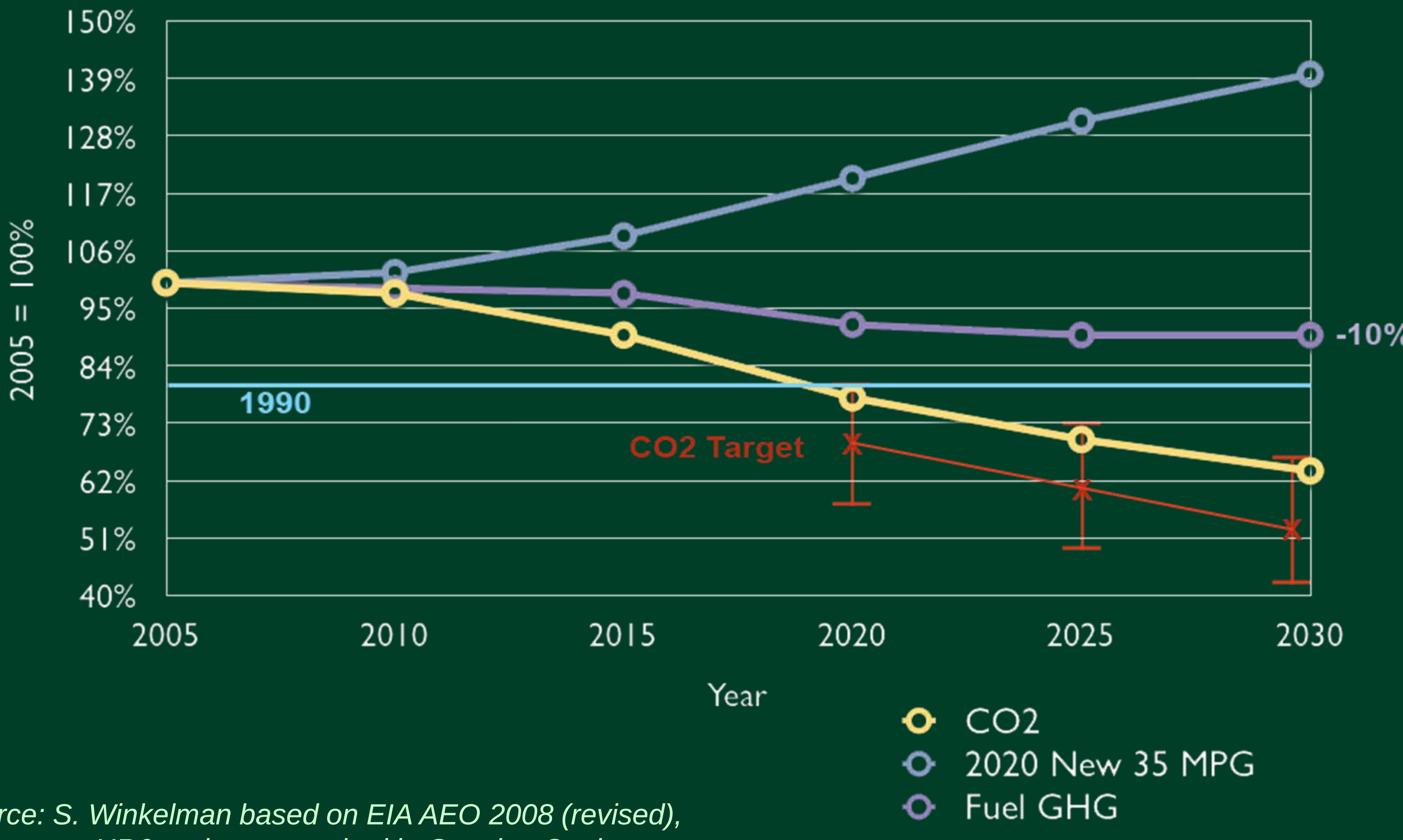

6°C
5°C
4°C
3°C
2°C
1°C
Entire regions experience major declines in crop yields
Rising number of people at risk from hunger
Sea level rise threatens major world cities
Significant changes in water availablility
Small mountain glaciers disappear
Many ecosystems affected
Many species face extinction
Coral reef eco-systems damaged
Rising intensity of storms, forest fires, droughts, flooding and heat waves
Increasing risk of abrupt, large-scale shifts in the climate system
Onset of irreversible melting of the Greenland ice sheet
Food
Water
Ecosystems
Extreme weather events
Risk of climate change & major irreversible impacts



Vehicles **Fuels** **VMT**

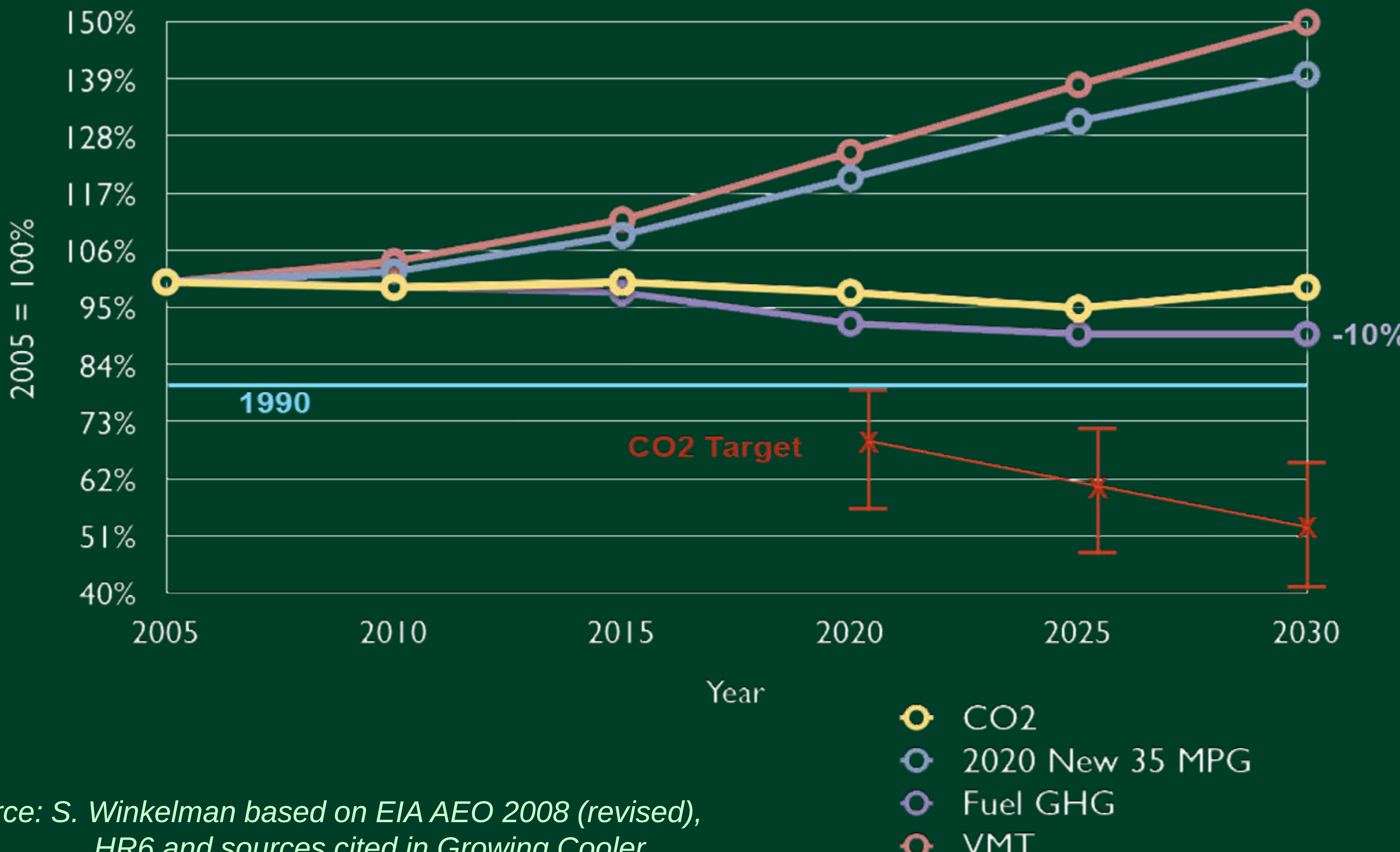



Effects of CAFÉ & Fuel GHG Goals Alone



Source: S. Winkelman based on EIA AEO 2008 (revised), HR6 and sources cited in Growing Cooler.

VMT Growth Prevents Reaching CO2 Target



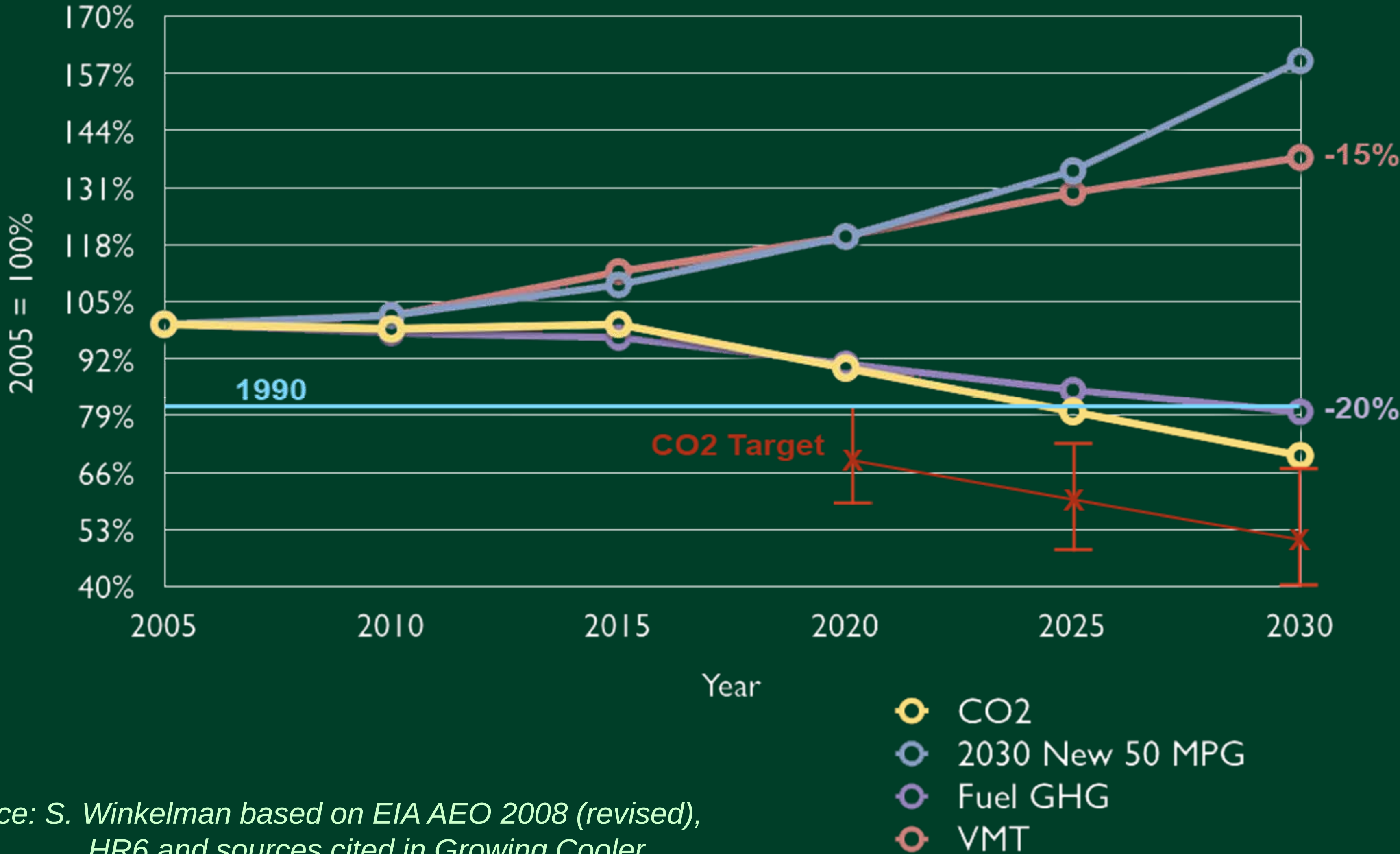
Source: S. Winkelman based on EIA AEO 2008 (revised), HR6 and sources cited in Growing Cooler.

VMT Reduction *through Pricing & Transit Improvements*

	VMT Elasticities with Respect to Policy Variables	Change in Annual Growth Rates of Policy Variables (% above/below Trend)	Effect on Annual VMT Growth Rate (% below Trend)
Real Fuel price	–0.17	2.7*	–14.4%
Transit Revenue Miles	–0.06	2.5	–4.6%
Population Density	–0.30	?	?

** Average annual real price growth rate has been less than 2% from 1963 to 2008, and from 1980 to 2008*

Add Pricing, Transit, & 50mpg CAFÉ Standards:
2030 CO2 is 15% Above Target



Source: S. Winkelman based on EIA AEO 2008 (revised), HR6 and sources cited in Growing Cooler.

Possible VMT Reduction from Compact Development

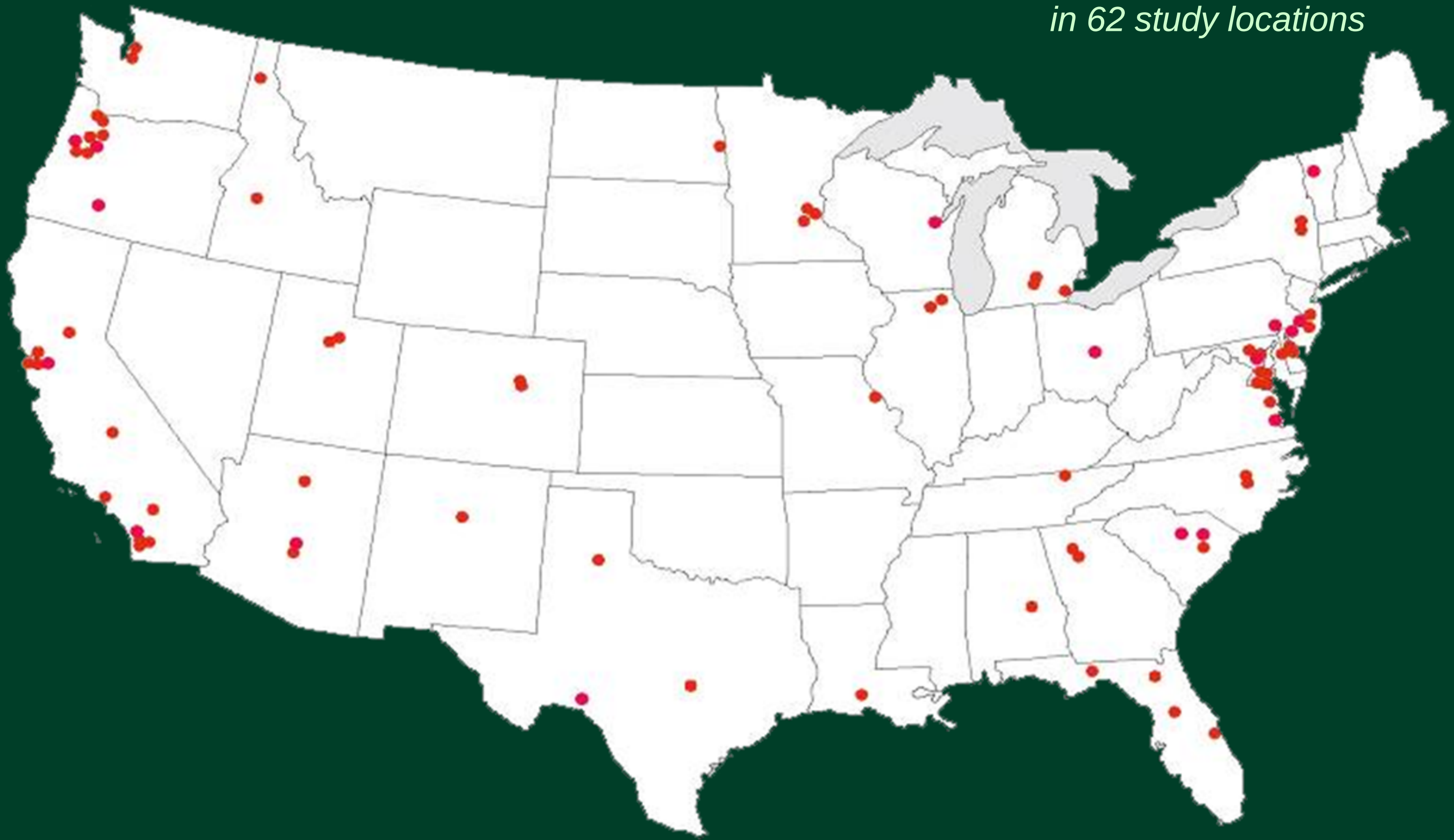
- How much compact development might occur?
- To what degree does compact development reduce VMT?

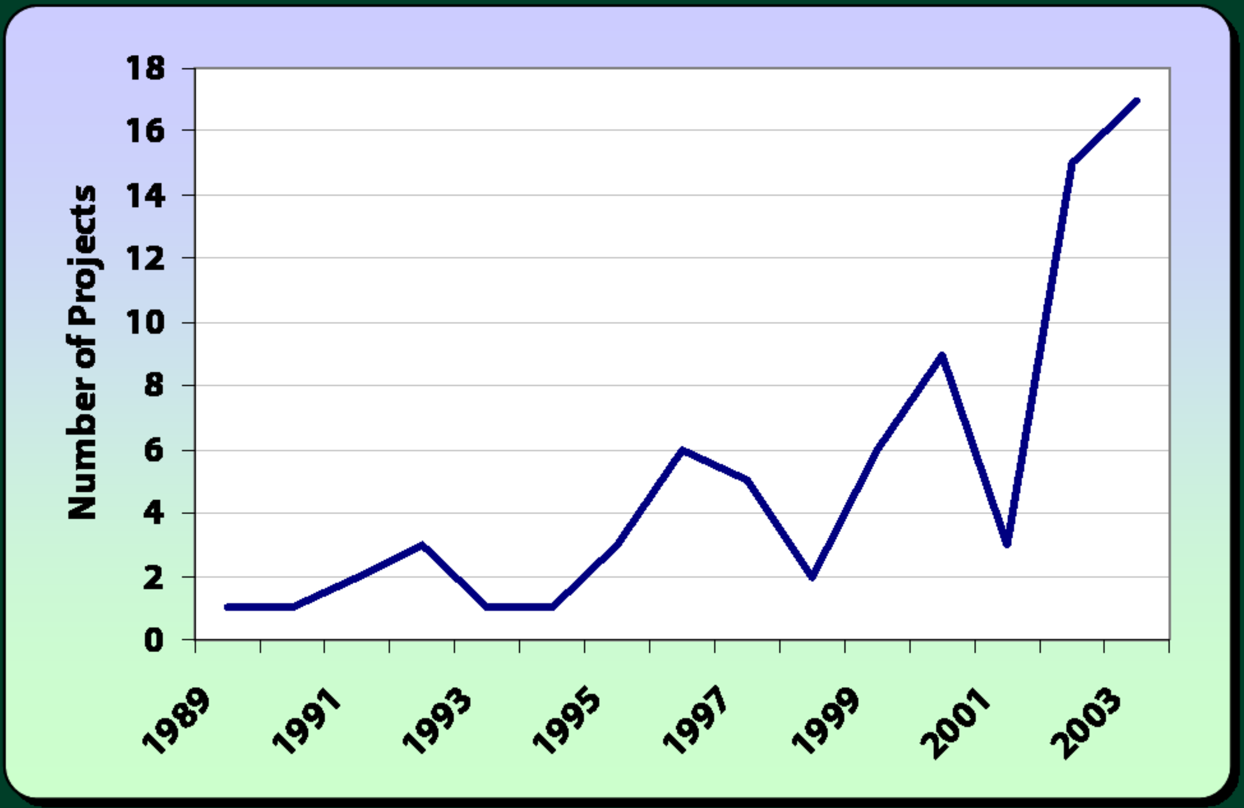
Estimates of Possible VMT Reduction

- **Aggregate travel studies**
- **Disaggregate travel studies**
- **Regional simulation studies**
- **Project simulation studies**

US Land Scenario Planning Studies

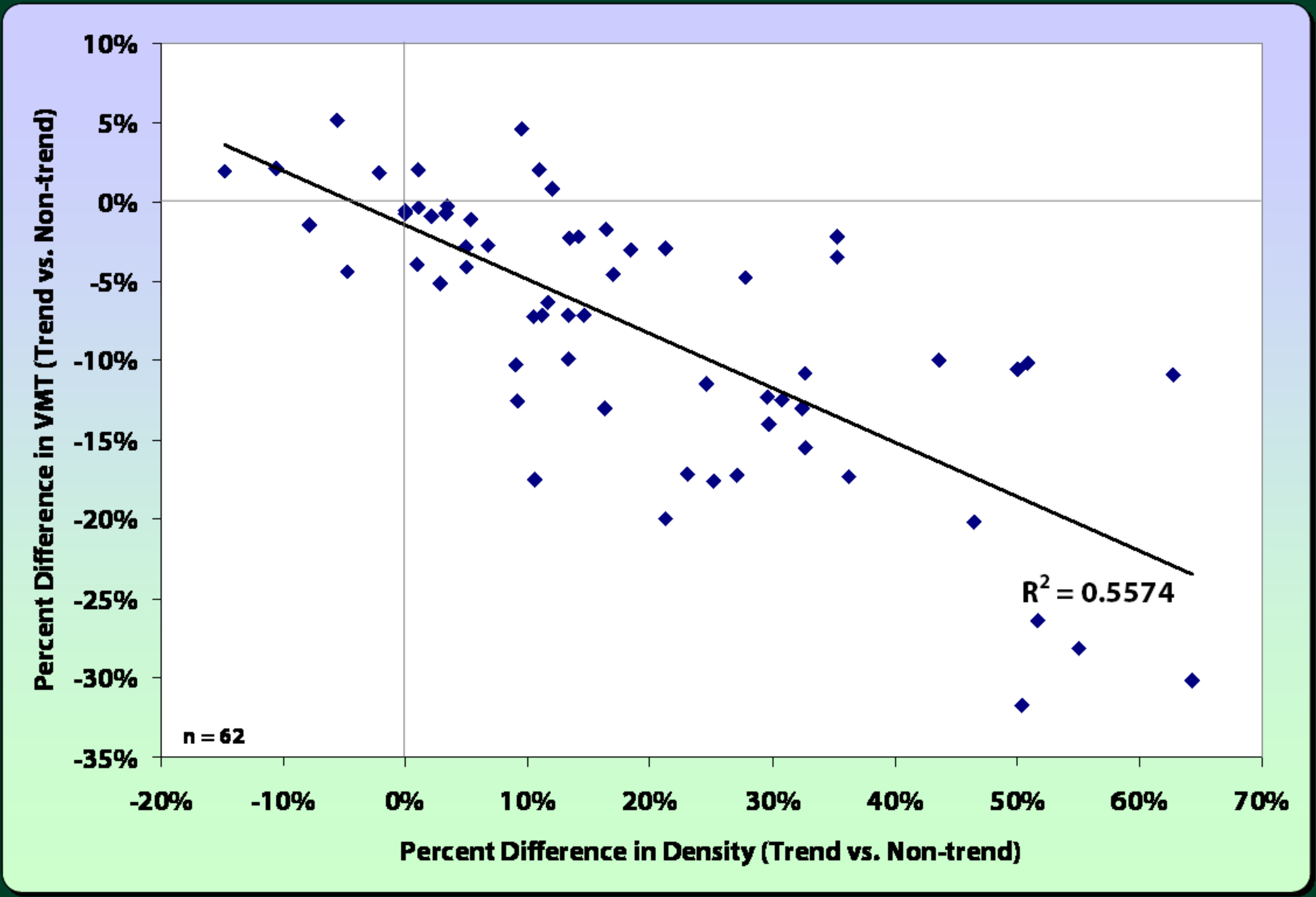
26% VMT reduction by 2050
in 62 study locations





U.S. Land Use-Transportation Scenario Planning Projects

Source: Bartholomew 2005



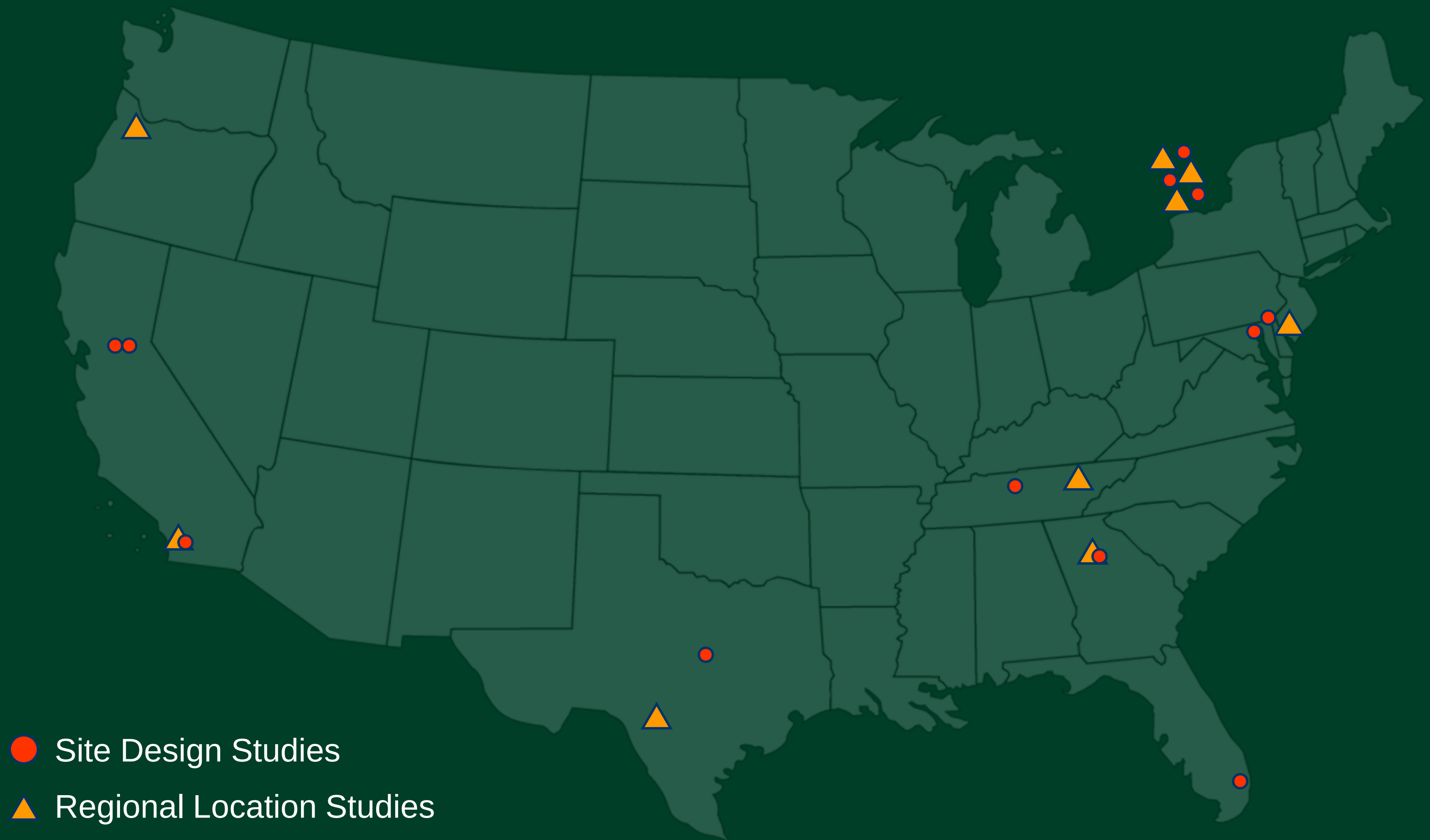
VMT versus Density

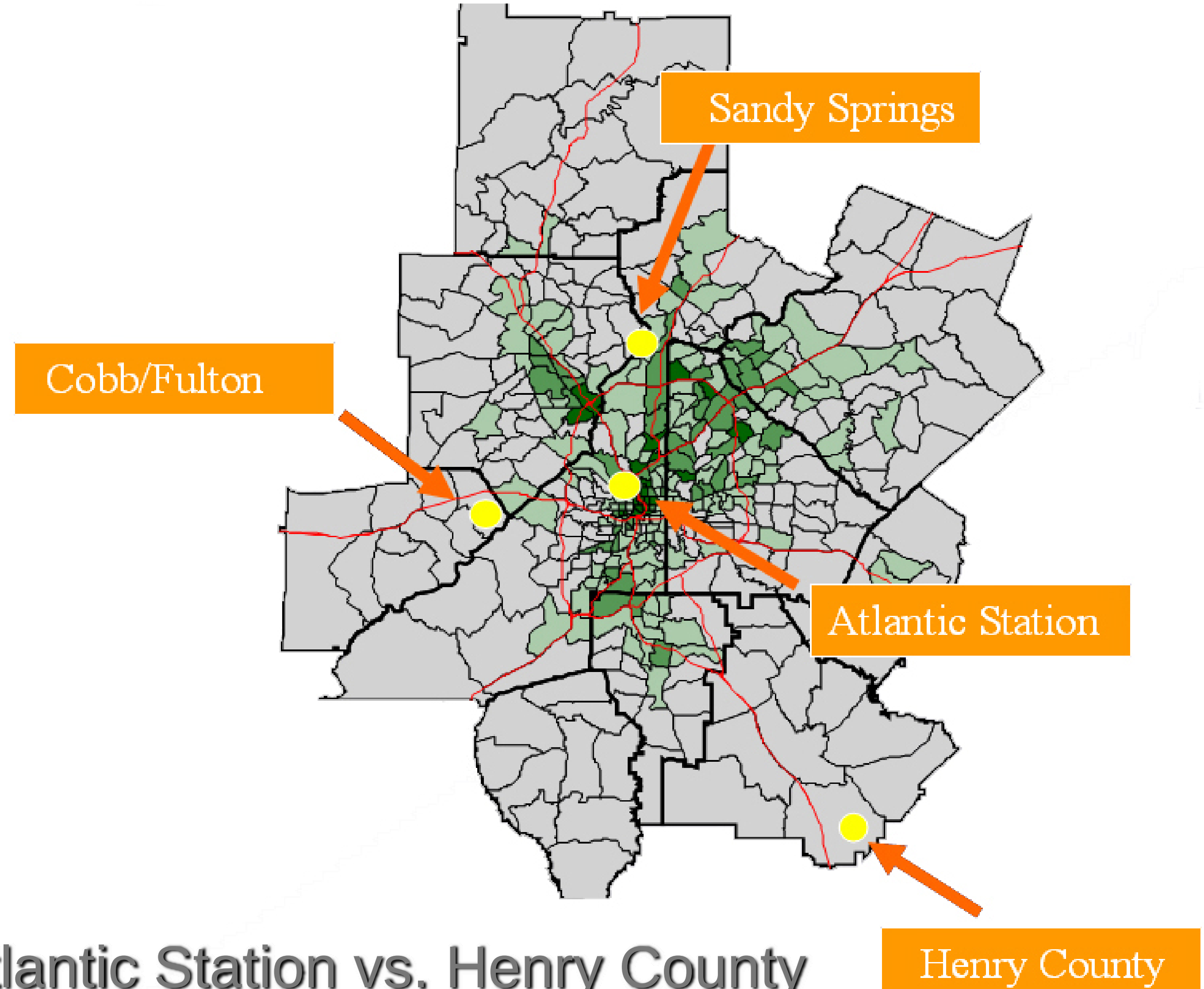
Source: Ewing, Bartholomew, et al. 2008

Figure 3-23
Best-Fit Model of Percent VMT Reduction Relative to Trend (with Robust Standard Errors)

	Coefficient	**t**	***P***
Difference in density (% above trend)	–0.074	–1.48	*0.15*
Development centralized	–1.50	–2.13	*0.037*
Land uses mixed	–4.64	–2.15	*0.036*
Population growth increment (% over base)	–0.068	–2.02	*0.056*
Transportation coordinated	*–2.12*	*–1.01*	*0.33*

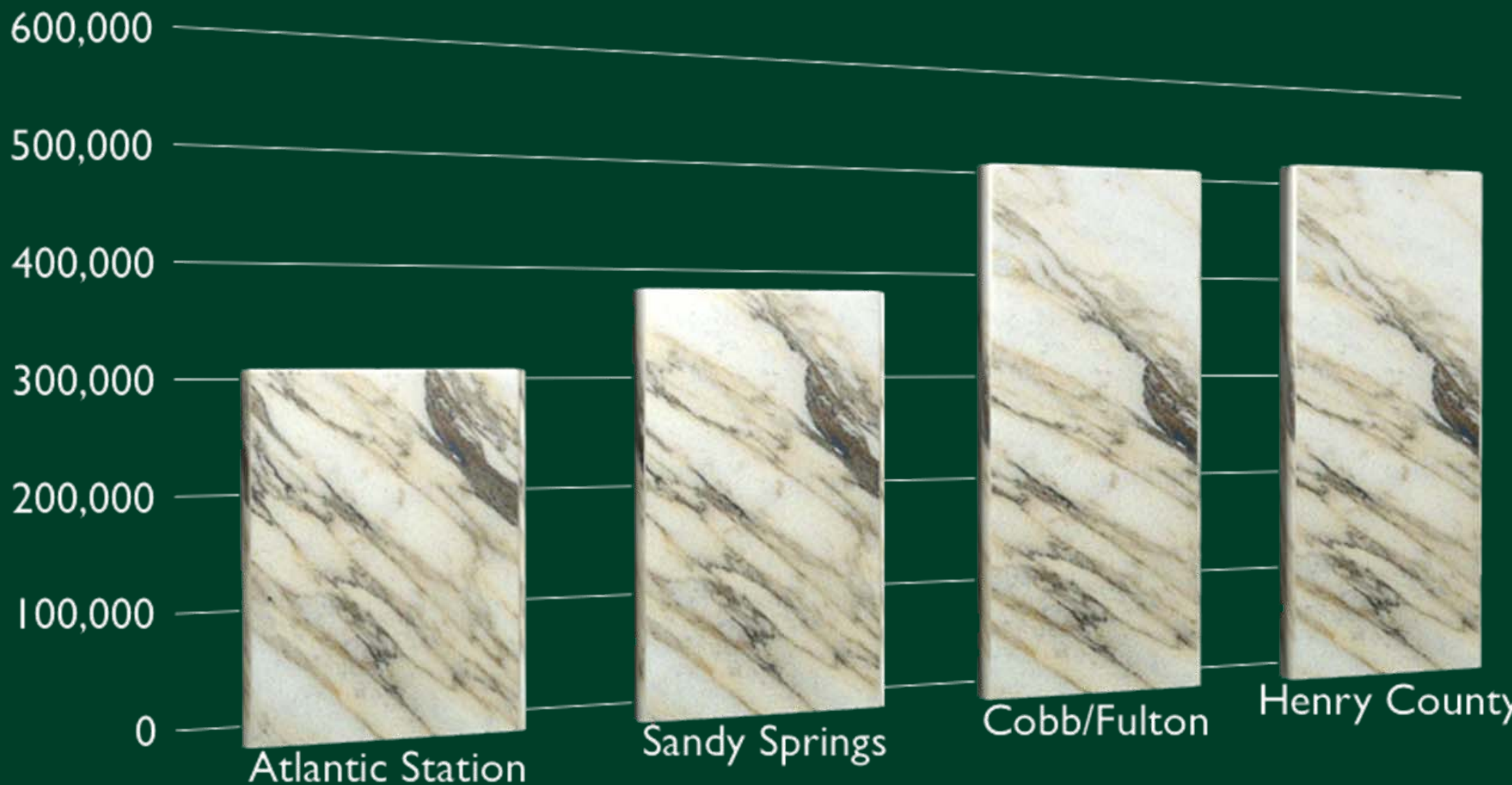
Site Design & Location Studies *in US and Canada*



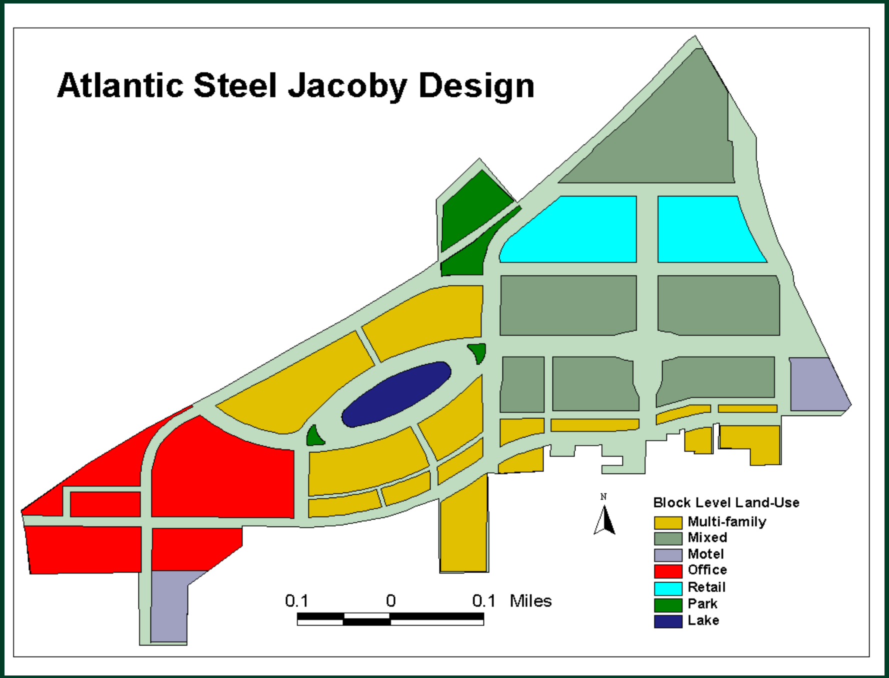


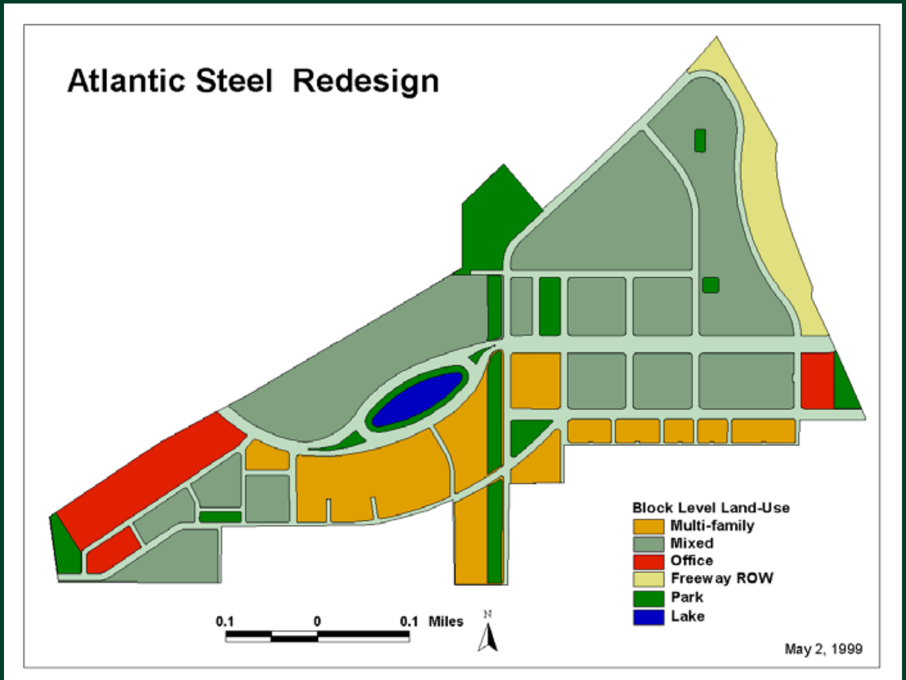
Atlantic Station vs. Henry County

33% Savings Due to Regional Accessibility



Alternative Site Plan Comparison





2% Savings Due to Site Design

Successful Community/Lower VMT than Predicted

Atlantic Station

Estimates of Possible VMT Reduction

- Aggregate travel studies: 35%
- Disaggregate travel studies: 40%
- Regional simulation studies: 26%
- Project simulation studies: 35%

Potential 2050 VMT Reduction due to Compact Development

60-90% Compact

x

67% New Development

x

30% VMT Reduction

=

12-18% Reduction in Metropolitan VMT

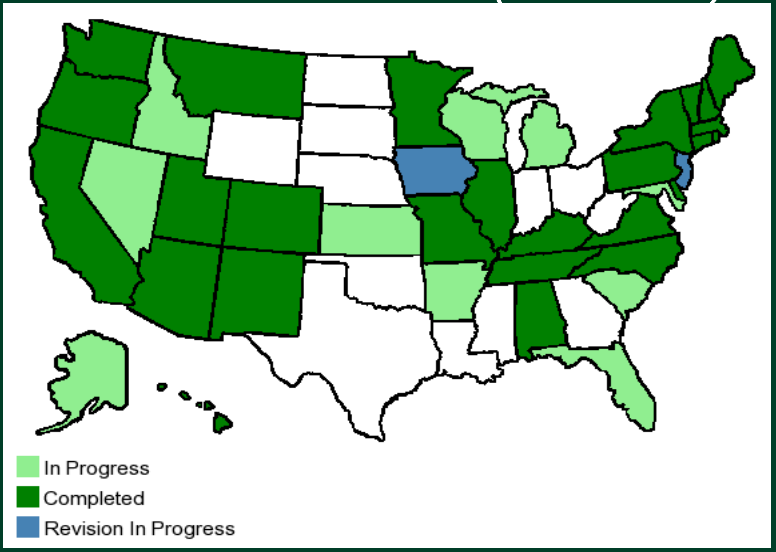
Part II – New Planning Challenges

New Planning Challenges

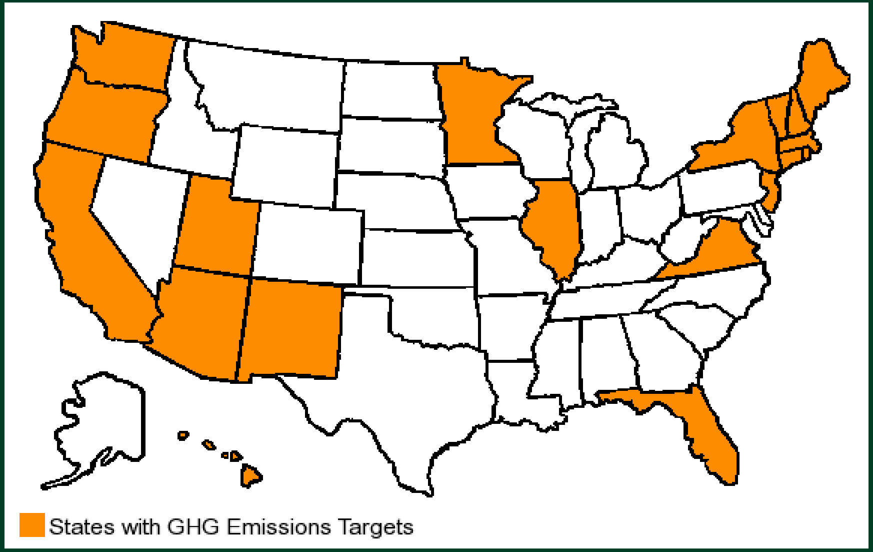
1. Political and Statutory Context
2. New Paradigm for Planners
   - Climate
   - Energy
   - Health

State Level Actions

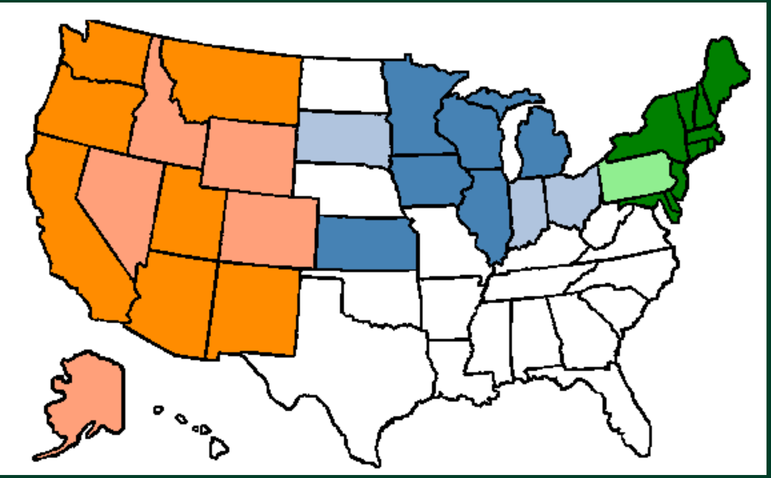
Climate Action Plans (38 States)



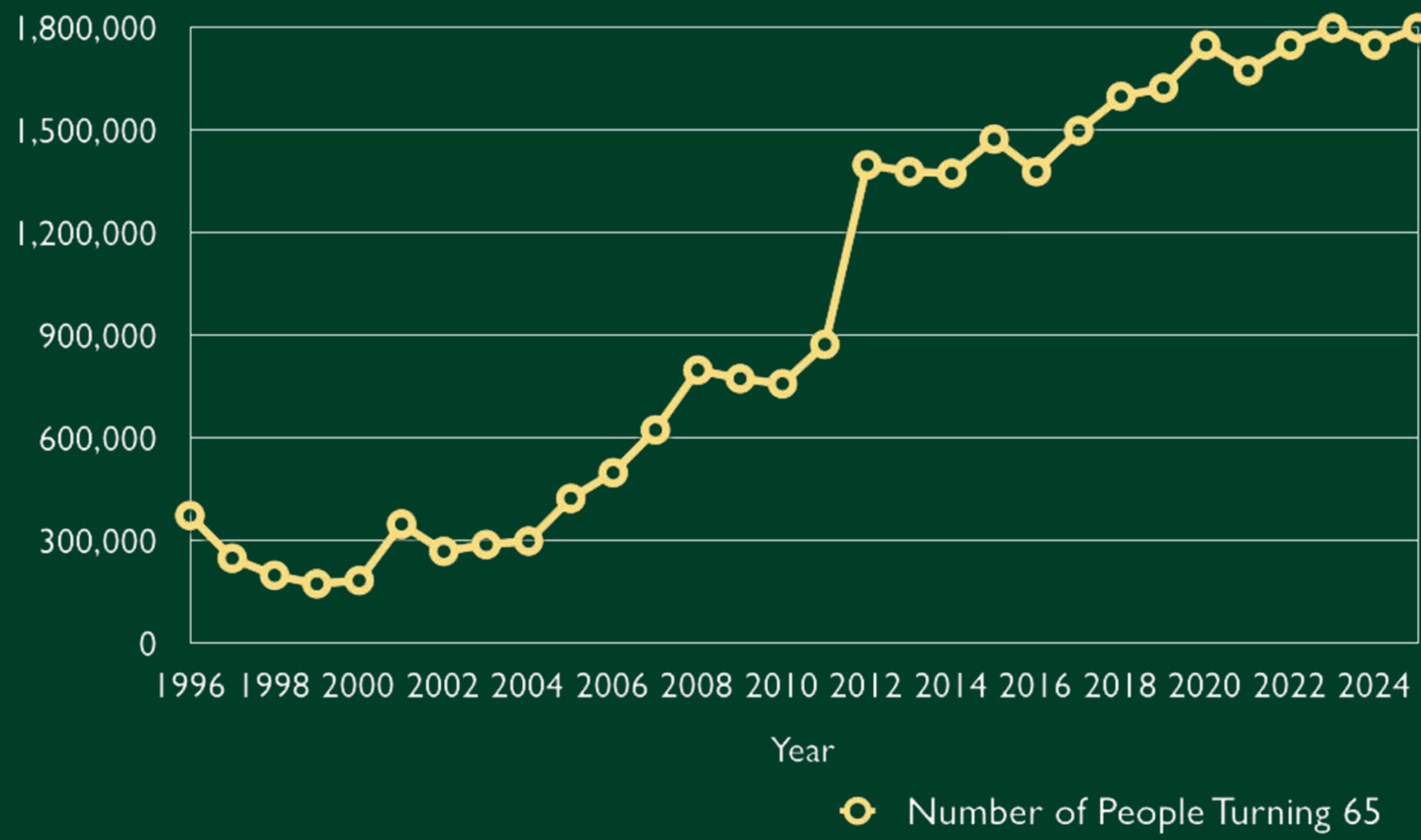
GHG Emissions Targets (19 States)



Regional Initiatives (32 states)



Demographic Drivers



US Statistics

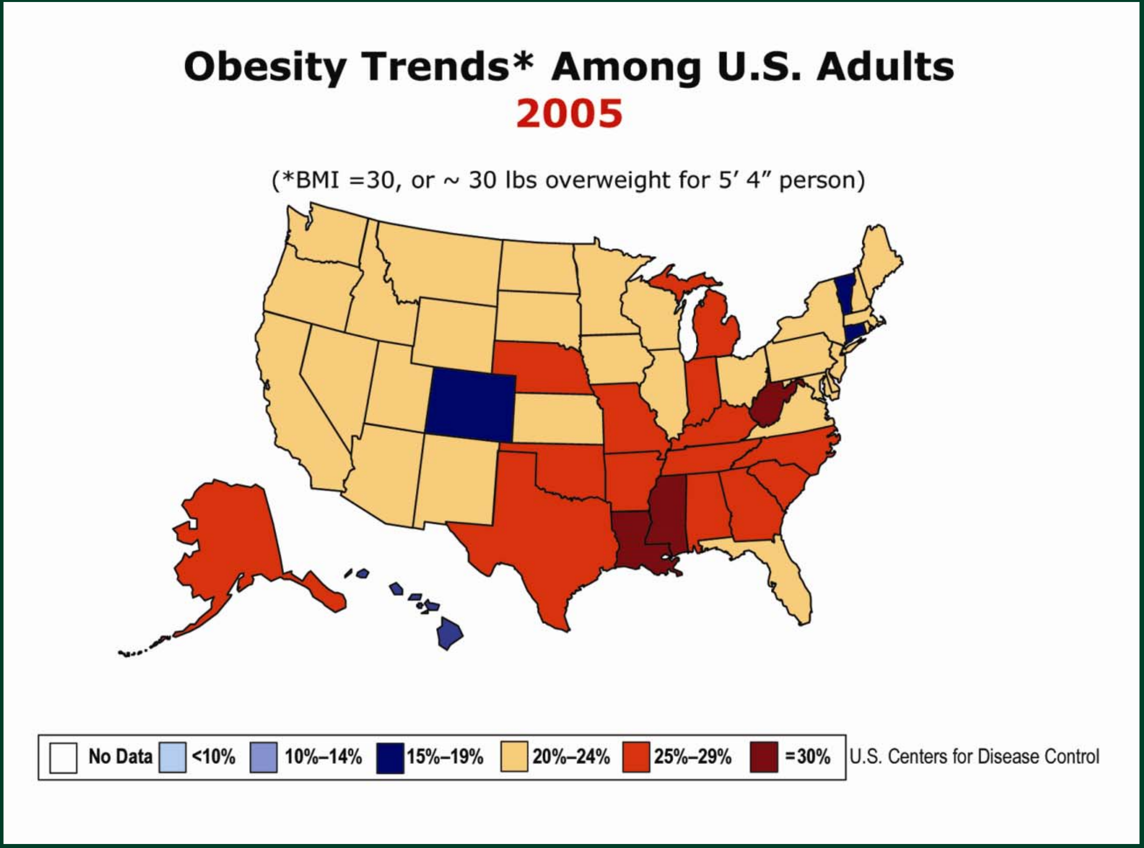
Market Considerations

- Average number turning 65 each year:
  - ***between 1996 and 2006: 300,000***
  - ***between 2015 and 2025: 1,700,000***
- Families without children in 2025: 72%
- Single person households in 2025: 28%
- 61% would prefer to live in smart growth communities
- Decline in housing value farther from regional center
- Annual gasoline real price increase 20% since 1998, 40% since 2007

US Statistics

Health Considerations

- **Auto oriented land use patterns**
- **Decreased walking and biking for short trips**
- **Lack of supporting infrastructure**



Balancing the Trade-Offs

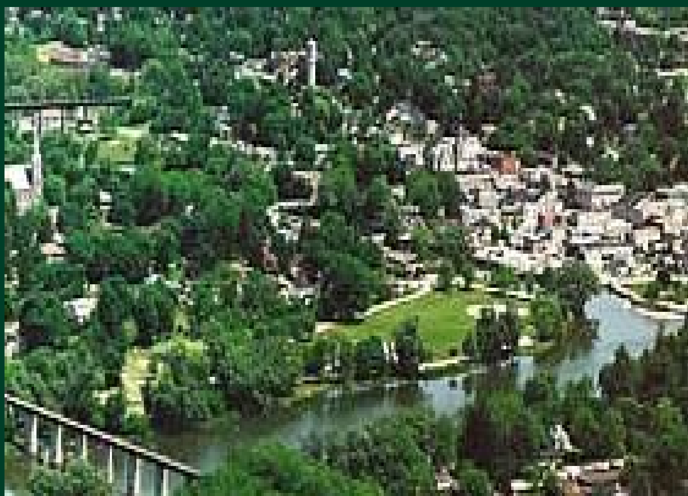
Addressing Climate & Energy in Planning & Impact Assessment

1. **Account for benefits of compact development and integrated multi-modal transportation**
2. **Quantify and mitigate VMT and trips per capita**
3. **Quantify and mitigate impacts to mobility and system stability**

LEED-ND Sustainable Development Criteria

- **Prerequisite: Smart Location**
  - Infill location, or VMT < regional average
- **Prerequisite: Compact Development**
  - ≥ 7 DU/acre, FAR ≥ 0.50
- **Credits for Smart Location and Linkage**
  - Brownfield, redevelopment, dense street grid, bike access
- **Credits for Neighborhood Pattern and Design**
  - Density, diversity, design, distance to transit, demand management

7 "D" factors that influence trip generation:



Density dwellings, jobs per acre

Diversity mix of housing, jobs, retail

Design connectivity, walkability

Destinations regional accessibility

Distance to Transit bus, rail proximity

Development Scale: population, jobs

Demographics household size, income

Density

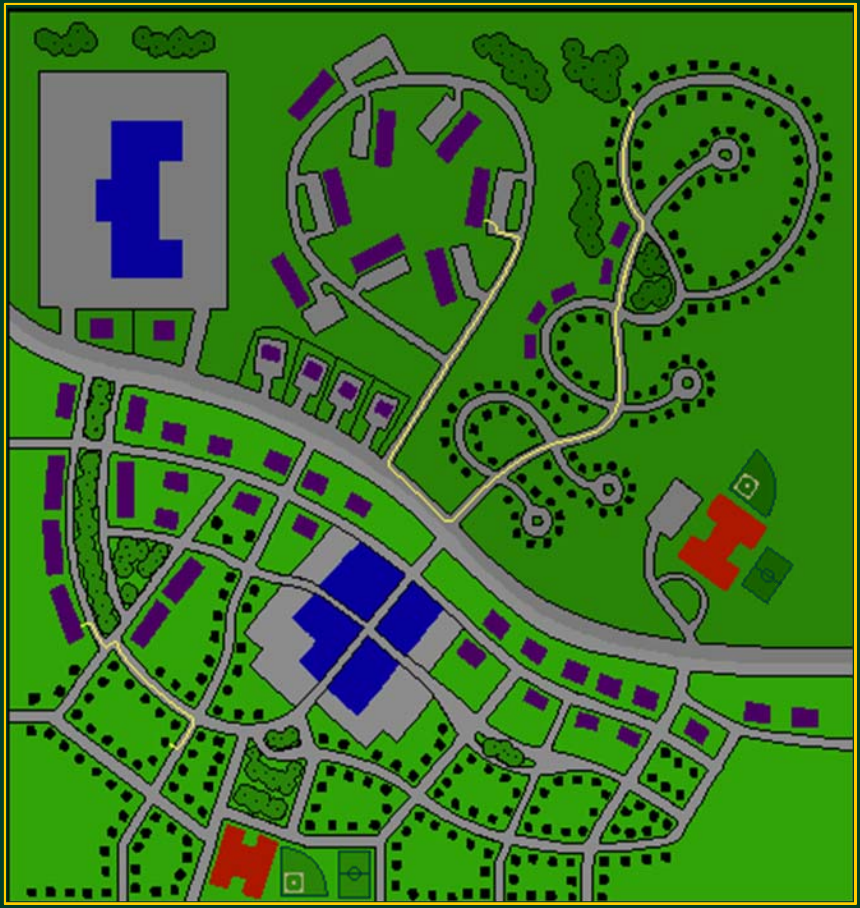
- Shortens traffic distances
- Walking/biking become possible for at least some trips
- Makes public transportation practicable
- Major influence on the amount of green-space conversion

Diversity

- **Shortens traffic distances**
- **Makes shared parking practicable (reduces need to pave green space)**

Design

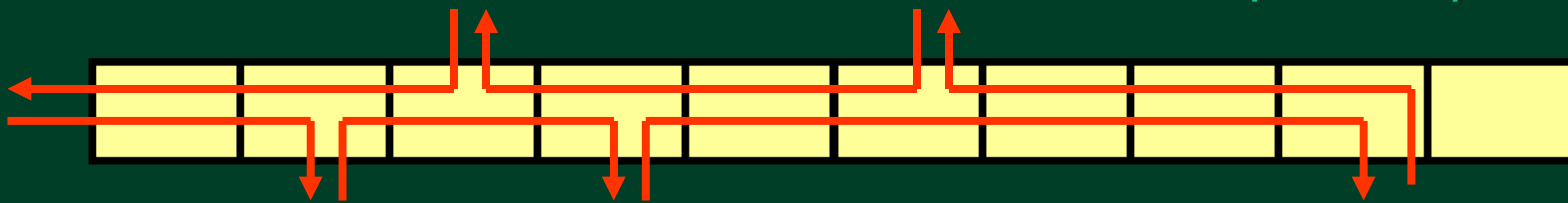
Cul-de-sacs lengthen travel distances and force trips onto highways



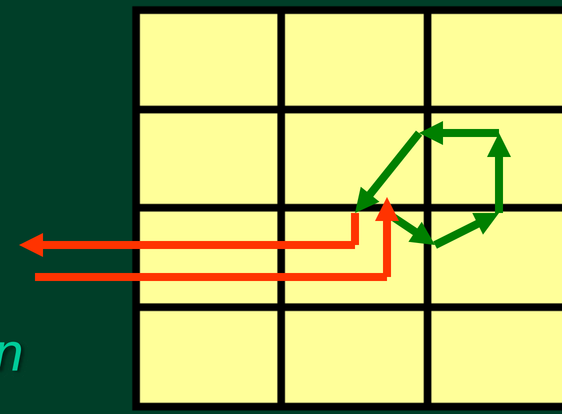
Grid pattern creates much shorter trips with less need to use the highway

Design

Strip development



6 vehicle trips
5 parking spaces
10 turning movements

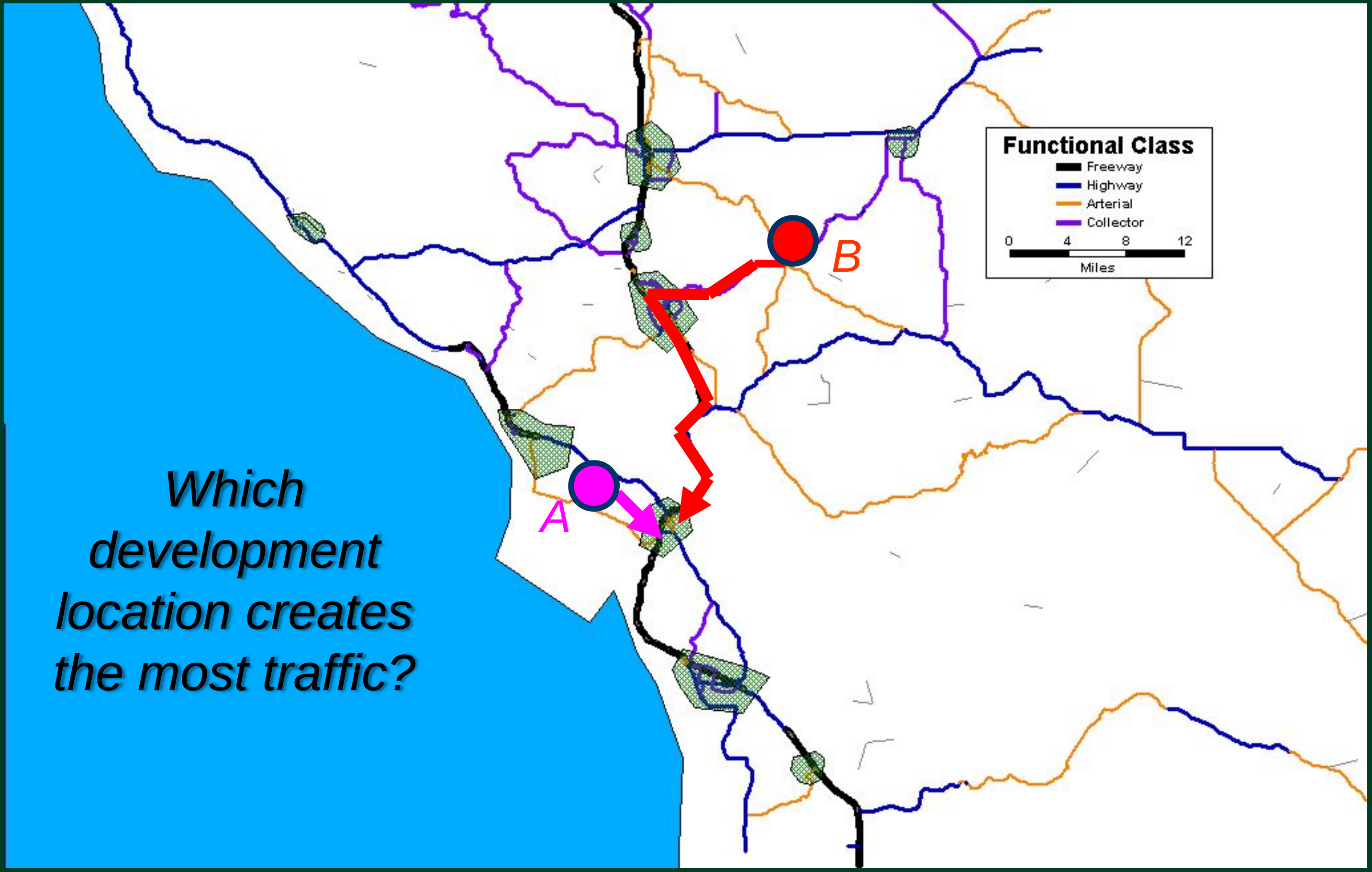


Exact same area, but average trip length is halved

Downtown

2 vehicle trips
1 parking space
2 turning movements

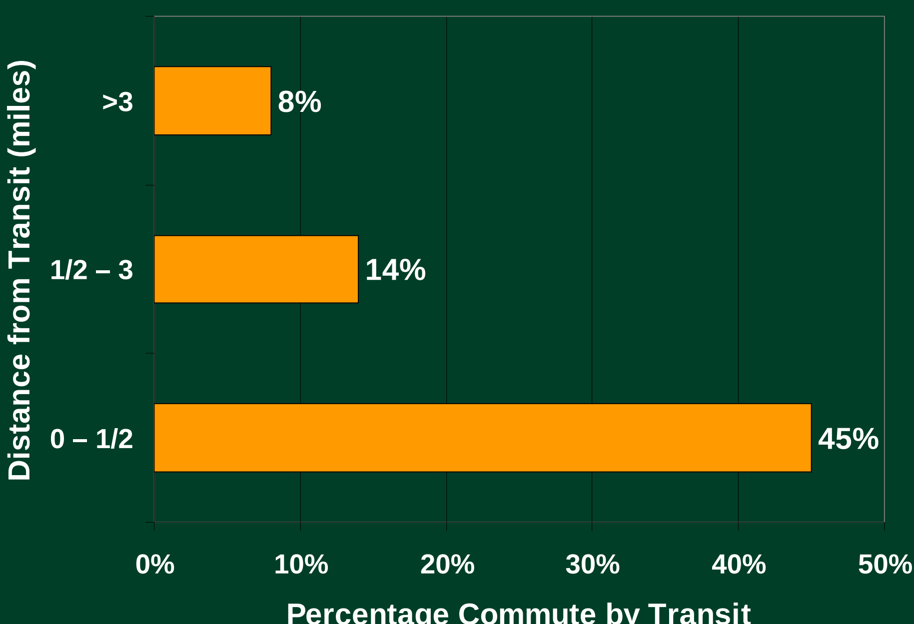
Destinations



Distance to Transit

- **¼ - ½ mile buffer is rule of thumb for walk access**

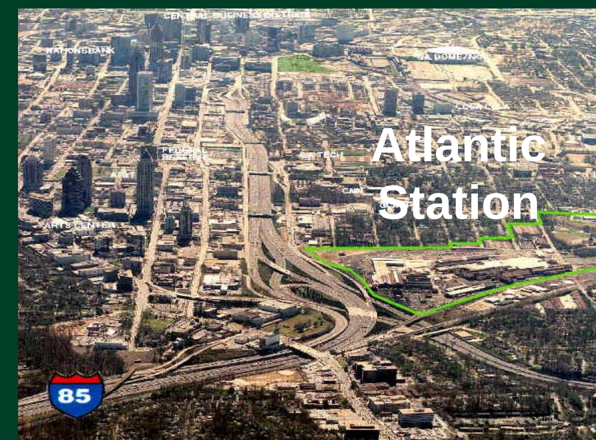
Pleasant Hill BART Station (2003 surveys)



Smart Growth Development Types

TOD

IND



MXD

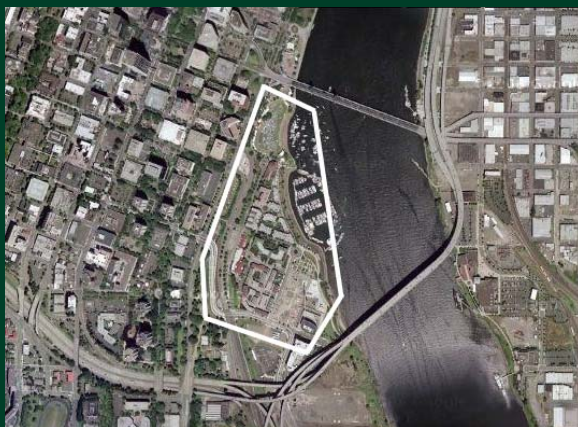
TND

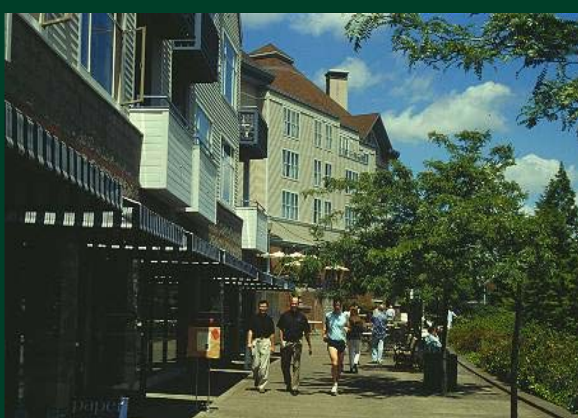
4D Elasticity Ranges

	Vehicle Trips Per Capita	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: National Syntheses, Twin Cities, Sacramento, Holtzclaw

Emerging Findings on Smart Growth Trip Generation





National studies of Mixed Use, TOD and Infill development

	MXD	TOD	Infill
Trip Discount	**30%**	**44%**	**36%**

Examples: San Diego, Seattle, Portland, Sacramento, Houston, Atlanta, Boston
Sources: EPA MXD, SANDAG SG TG, TCRP H-27A, Caltrans , Trip Generation Rates for Urban Infill

Practical Challenges:
Conventional Technical Methods & Models

- **Regional travel demand models are not sensitive to "D" characteristics**
- **Traffic Impact Analysis (TIA) methods are almost solely focused on motorist delay**

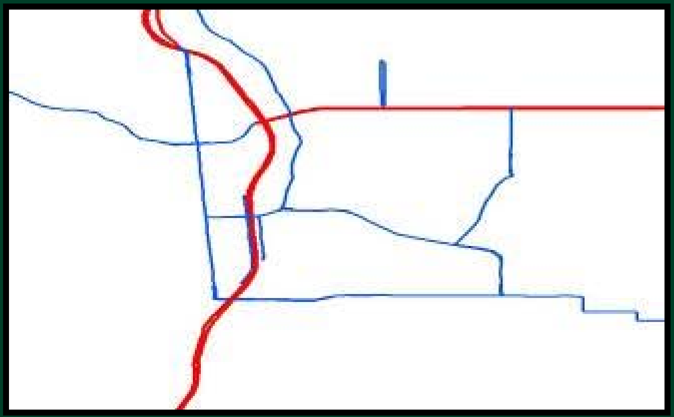
Shortcomings of Conventional Travel Models in Assessing Smart Growth

- Primary use is to forecast long-distance auto travel on freeways and major roads
- Secondary use is to forecast system-level transit use
- Short-distance travel, local roads, non-motorized travel modes are not addressed in model validation

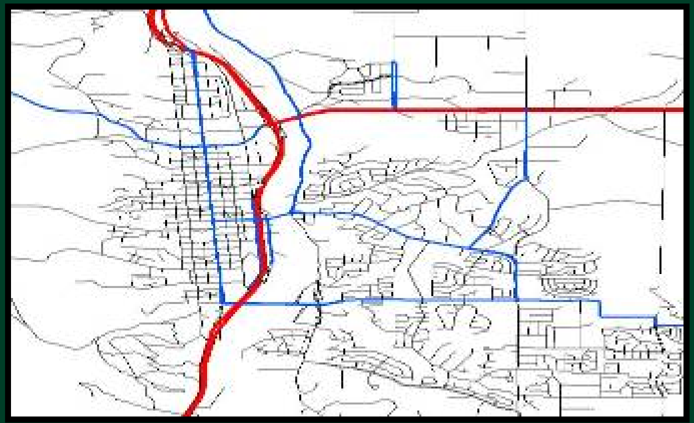
Typical Model "Blind Spots"

- **Abstract consideration of distances between land uses within a given TAZ or among neighboring TAZ's**
- **Limited or no consideration intra-zonal or neighbor-zone transit connections**

Network in Model



Network in Field

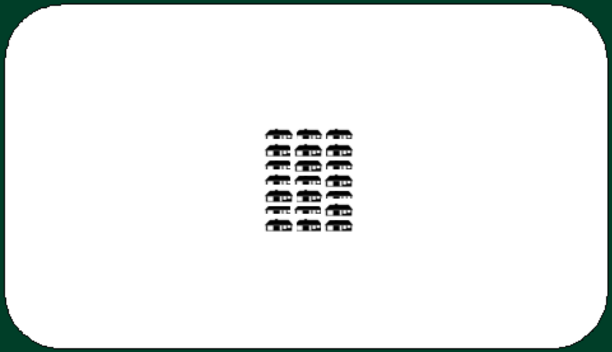


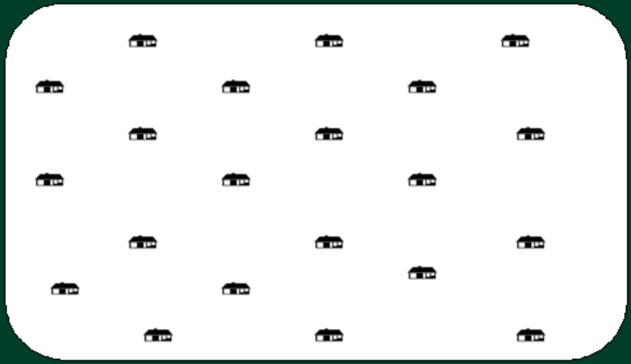
Typical Model "Blind Spots"

- **Sidewalk completeness, route directness, block size generally not considered**

Typical Model "Blind Spots"

- **Little consideration is given to spatial relationship between land uses within a given TAZ (density)**

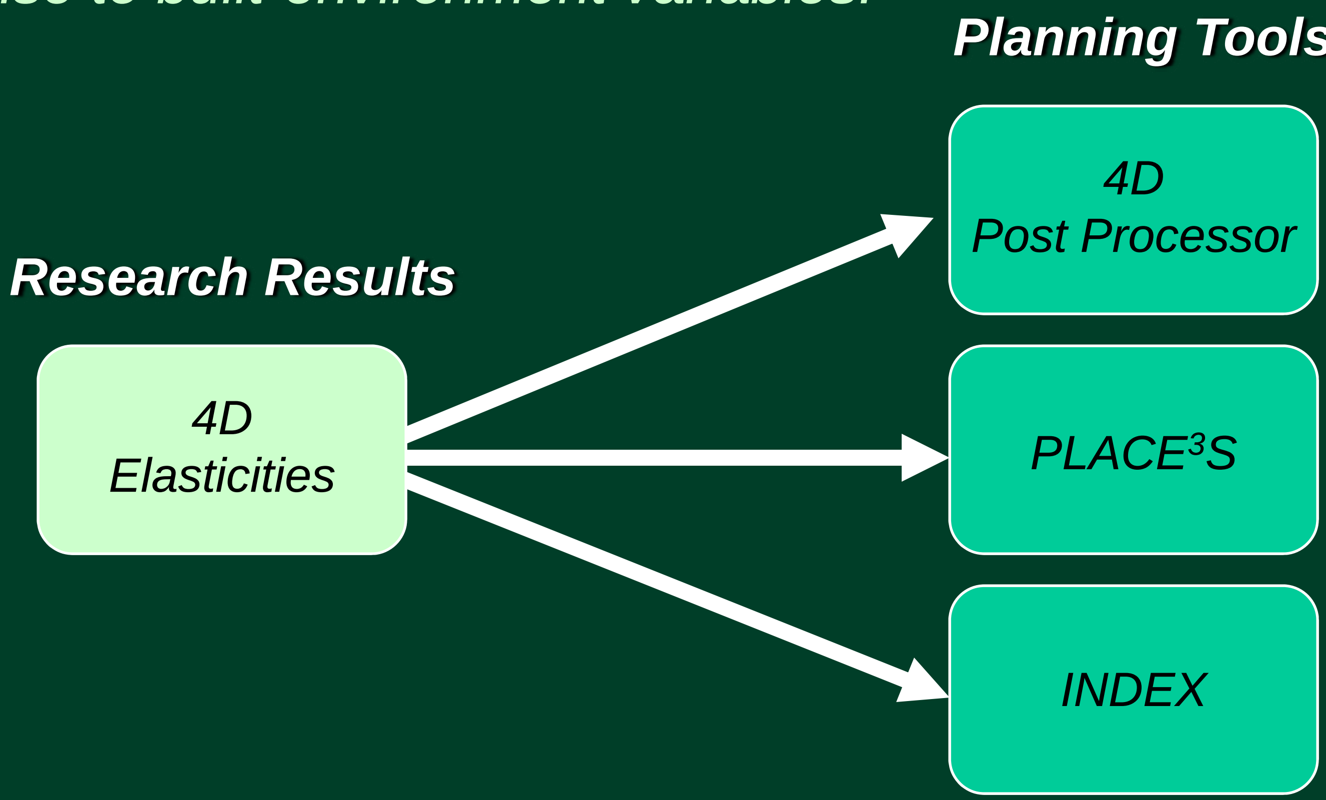




- **Interactions between different non-residential land uses (e.g. offices and restaurants) not well represented**

Caltrans Study Recommendation

Use 4D's to compensate for any lack of sensitivity in travel model response to built-environment variables.



Source: Assessment of Local Models and Tools for Analyzing Smart-Growth Strategies,2007

Other Supply-Side Factors

- Transit multiplier effects
- Effects of congestion on MPG and CO_2 / VMT
- Induced investment, induced travel

Institute of Transportation Engineers (ITE) Trip Generation Rates

- **Traditional TIAs use ITE average trip generation rates for traffic analysis**
- **Appropriate for average development types**
- **ITE suggests that projects with unique “D” characteristics should include adjustments to the average rates**

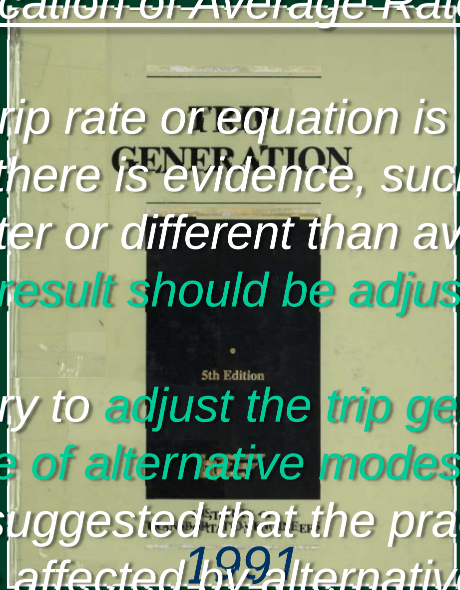
ITE Recommended Adjustments

***Trip Generation* 5th Edition**

"Modification of Average Rate or Equation

The use of an average trip rate or equation is applicable if the site is likely to be average in nature. If there is evidence, such as through a market analysis, that the site may be better or different than average, the average trip rate or equation result should be adjusted accordingly.

It may also be necessary to adjust the trip generation rates provided in this report to reflect the use of alternative modes of transportation. In making these adjustments, it is suggested that the practitioner estimate the portion of the trips most likely to be affected by alternative modes and adjust this portion of the trips."



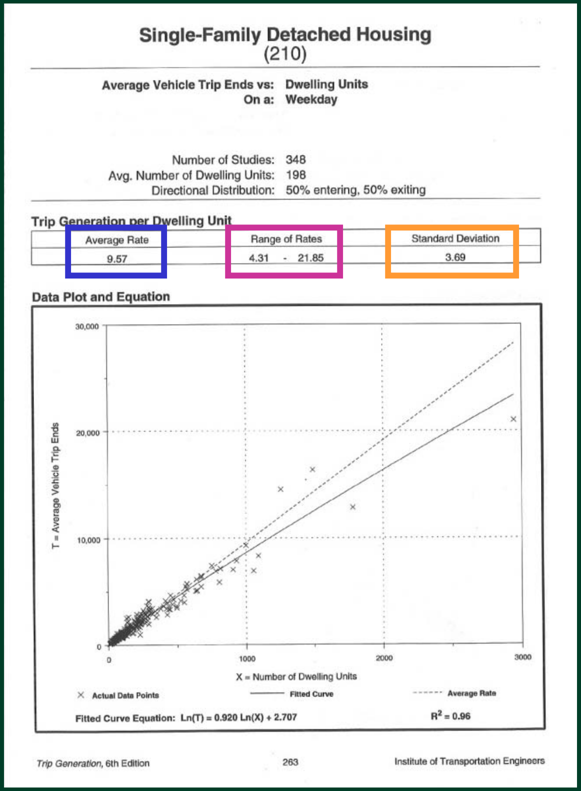
1991

ITE Trip Generation Rates

Average Rate
9.57

Range of Rates
4.31 - 21.85

Field-measured rates vary widely



Single-Family Detached Housing
(210)

Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 348
Avg. Number of Dwelling Units: 198
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.57	4.31 - 21.85	3.69

Data Plot and Equation

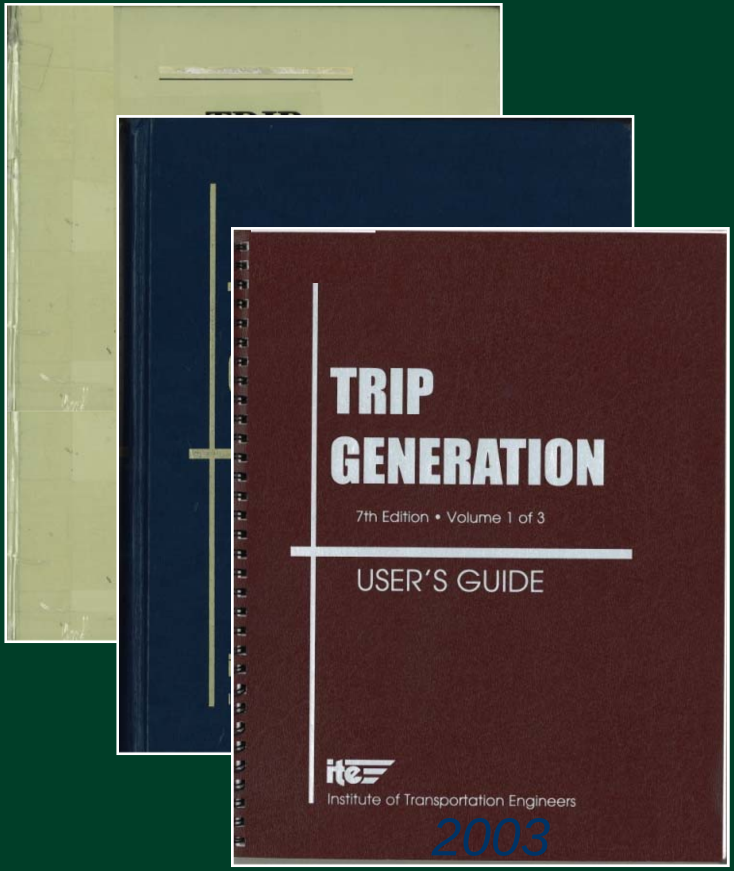
Trip Generation, 6th Edition 263 Institute of Transportation Engineers

Standard Deviation
3.69

Range of normal experience is 5.88 – 13.26

ITE Recommended Adjustments

- ***Trip Generation* 5th Edition recommended adjusting rate**
- **6th Edition added pedestrian amenities and TDM programs as additional reasons for adjustments**
- **7th Edition added a whole new chapter on adjustments for mixed-use developments**



Basis for Adjustments

- Adjustment factors (elasticities) were developed for the SACOG Blueprint Project
- Initial data from SACOG's 2000 Household Travel Survey (3,200 households)
- Growing data sets from Salt Lake City, Denver, San Diego
- Accepted at the highest levels
  - US-EPA's Award for Smart Growth Achievement
  - FHWA's Transportation Planning Excellence Award
  - AMPO's National Award for Outstanding Achievement
  - AIA's Presidential Citation
  - Numerous state awards

ITE Mixed-Use Adjustment

Rationale: When complementary land uses are in the same site, some trips will be internalized

Method: Estimate the potential for local trips for each land use, and take the smaller number for each interaction

Example:

Limitation: Only considers mix of uses

300 potential local trips

Use 50

50 potential local trips

4D Adjustment Method

Rationale: **Surveys show that certain neighborhood characteristics have a significant effect on travel behavior (Density, Diversity, Design, Destinations)**

Method: **Determine how much above/below average the neighborhood is for each characteristic, and multiply this by the adjustment factor (elasticity)**

Example:

Average Residential Density	3	DU/Acre
Project Residential Density	5	DU/Acre
More dense than average	67%	
Elasticity of VT to Density	-0.12	
Expected Reduction in VT	-8%	

Limitation: **R… cs**

Distance to Transit Adjustments

Rationale: **Surveys show that TOD residents use cars much less than other people in the same city**

Method: **local ... it use ... f**
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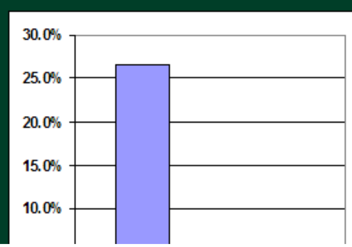
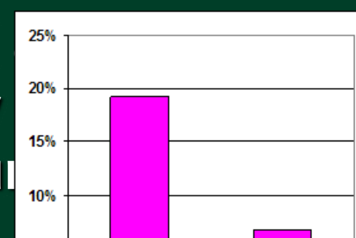
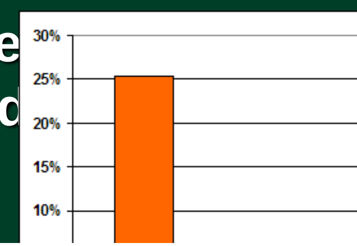
Transit Mode Share







Commute Share by Transit for Surveyed Cities

TODs	26.5%
Rest of City	5.4%
Ratio TOD/City	4.91
* Average for This City	3.5%
Expected for TOD	17.2%
- Average for This City	3.5%
Additional Reduction for TOD	13.7%

Work/Non-Work Trip Purpose

	Work			Non-Work		
	Daily	AM	PM	Daily	AM	PM
Residential	21%	70%	70%	79%	30%	30%
Retail	20%	10%	10%	80%	90%	90%
Office	18%	80%	80%	82%	20%	20%
Hotel	25%	20%	20%	75%	80%	80%

Vehicular Mode Split by Trip Purpose

	Work			Non-Work		
	Daily	AM	PM	Daily	AM	PM
Residential	71.7%	71.7%	71.7%	87.1%	87.1%	87.1%
Retail	77.8%	77.8%	77.8%	68.3%	68.3%	68.3%
Office	77.8%	77.8%	77.8%	39.5%	39.5%	39.5%
Hotel	57.7%	57.7%	57.7%	97.6%	97.6%	97.6%

TODs Rest of City TODs Rest of City

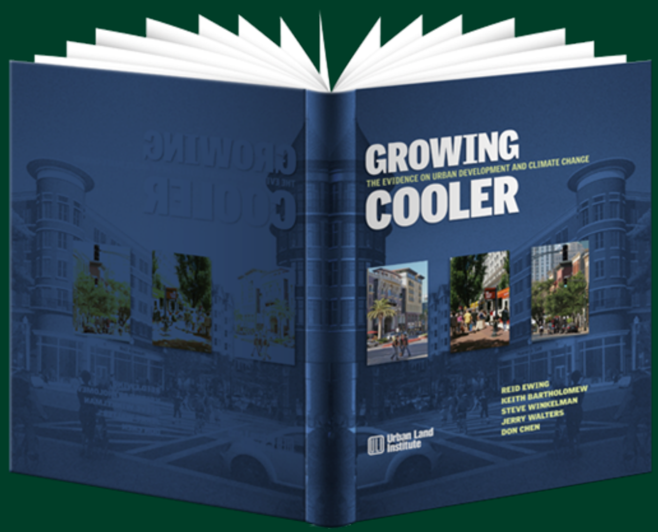
Conclusions for Transportation Planners

- Climate change and energy use are important issues for society, our clients and our profession.
- Standard models and ITE methods don’t capture the effects, but adjustments are permitted.
- New research and methods are available to improve standard methods.
- Planners and engineers should objectively apply best-practices to plan and evaluate sustainable development proposals.

Conclusions for Land Use Planners

- Probably will not meet CO2 reduction goals without TOD/Smart Growth.
- Market Demand for TOD/Smart Growth is Strong & Growing.
- Plans & Zoning Codes will need to be revamped to facilitate the demand.
- Public investments in infrastructure and public space design will need to be re-geared to support TOD/Smart Growth .

Part III – Q & A



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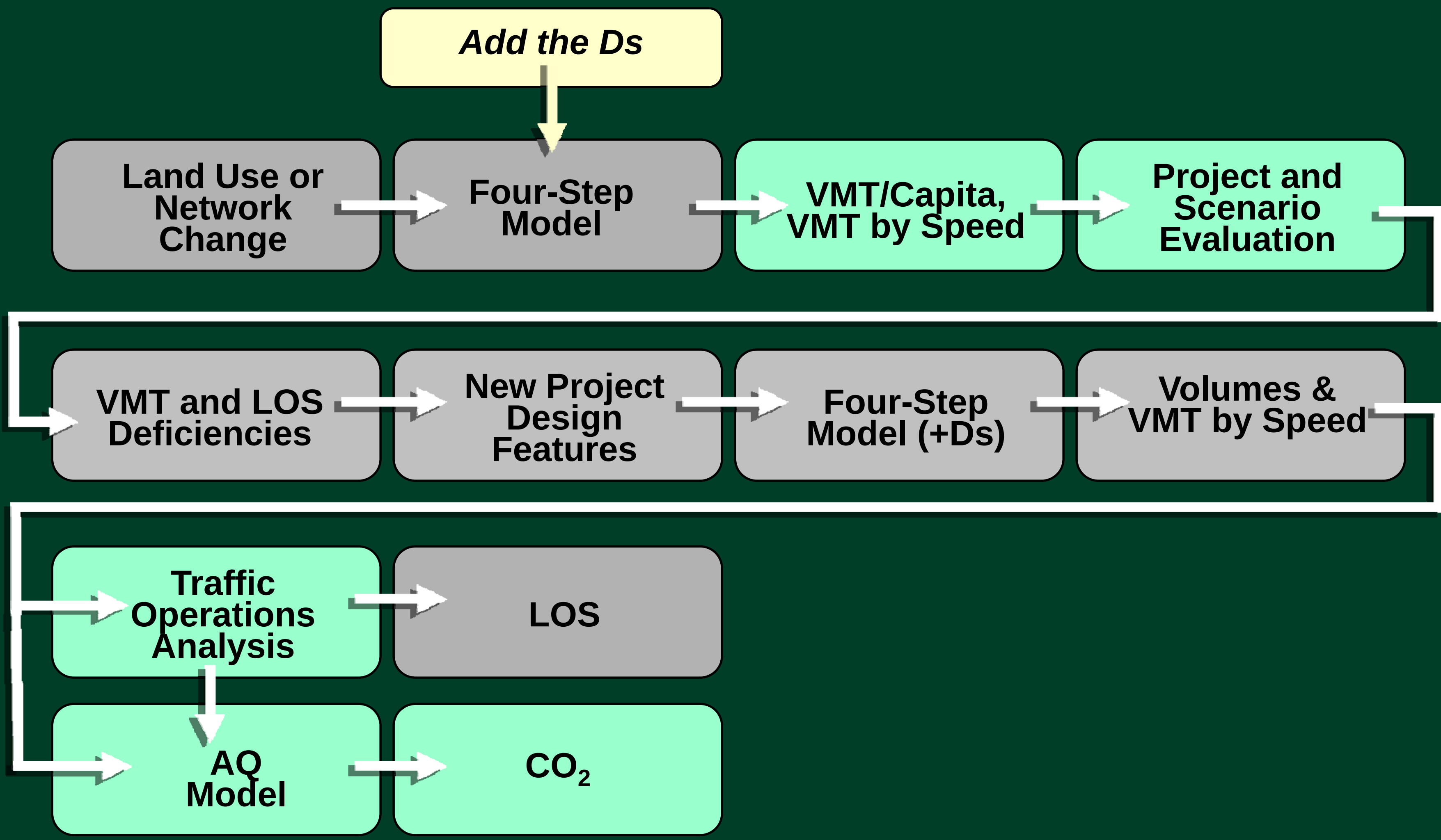
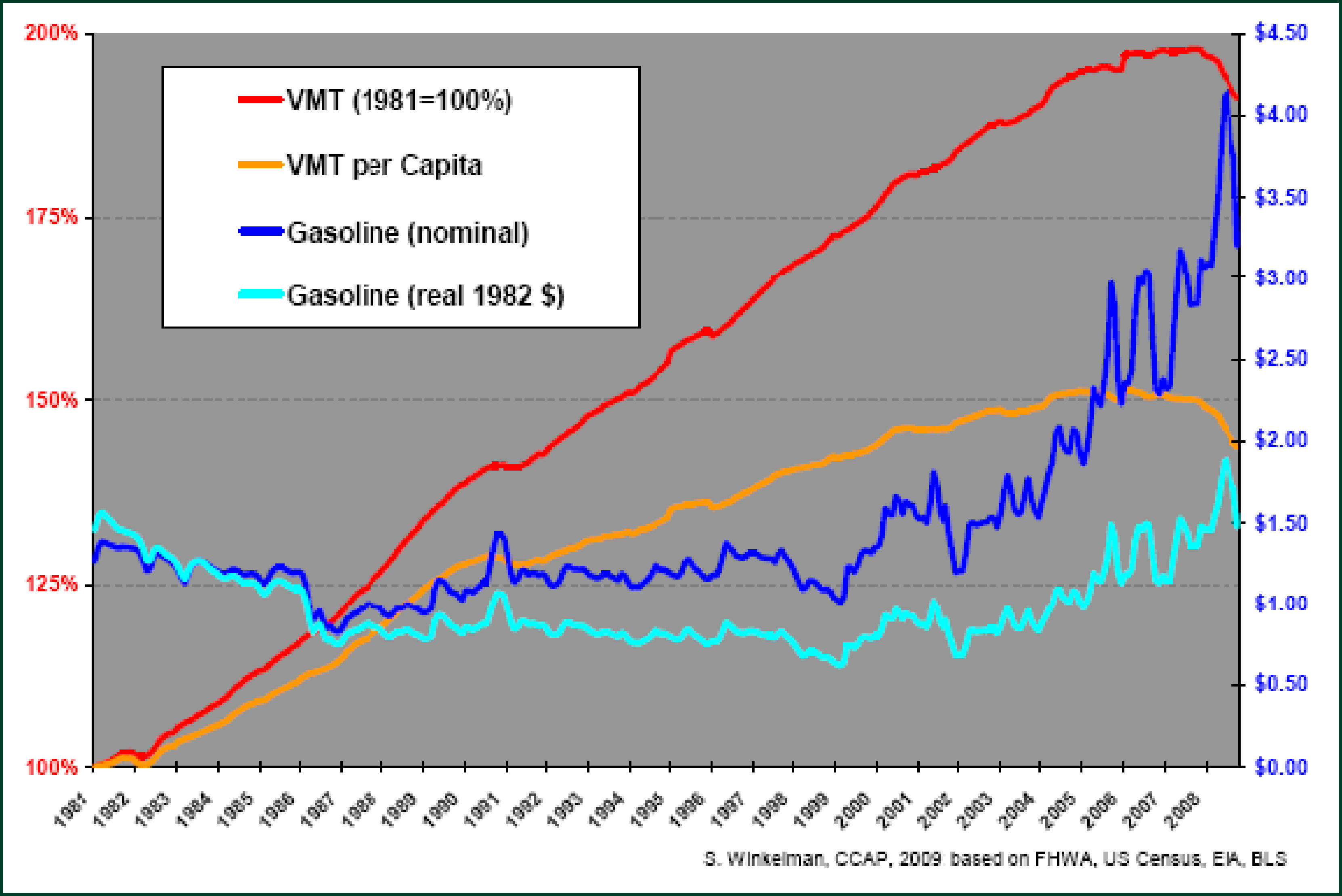
Jeremy R. Klop
Fehr & Peers


Add the Ds
Land Use or Network Change
Four-Step Model
VMT/Capita, VMT by Speed
Project and Scenario Evaluation
VMT and LOS Deficiencies
New Project Design Features
Four-Step Model (+Ds)
Volumes & VMT by Speed
Traffic Operations Analysis
LOS
AQ Model
CO_2


VMT (1981=100%)
VMT per Capita
Gasoline (nominal)
Gasoline (real 1982 $)
200%
175%
150%
125%
100%
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
S. Winkelman, CCAP, 2009 based on FHWA, US Census, EIA, BLS