



Georgia Tech Seminar – October 29, 2007

Implementing Sustainable Transportation at State DOT's

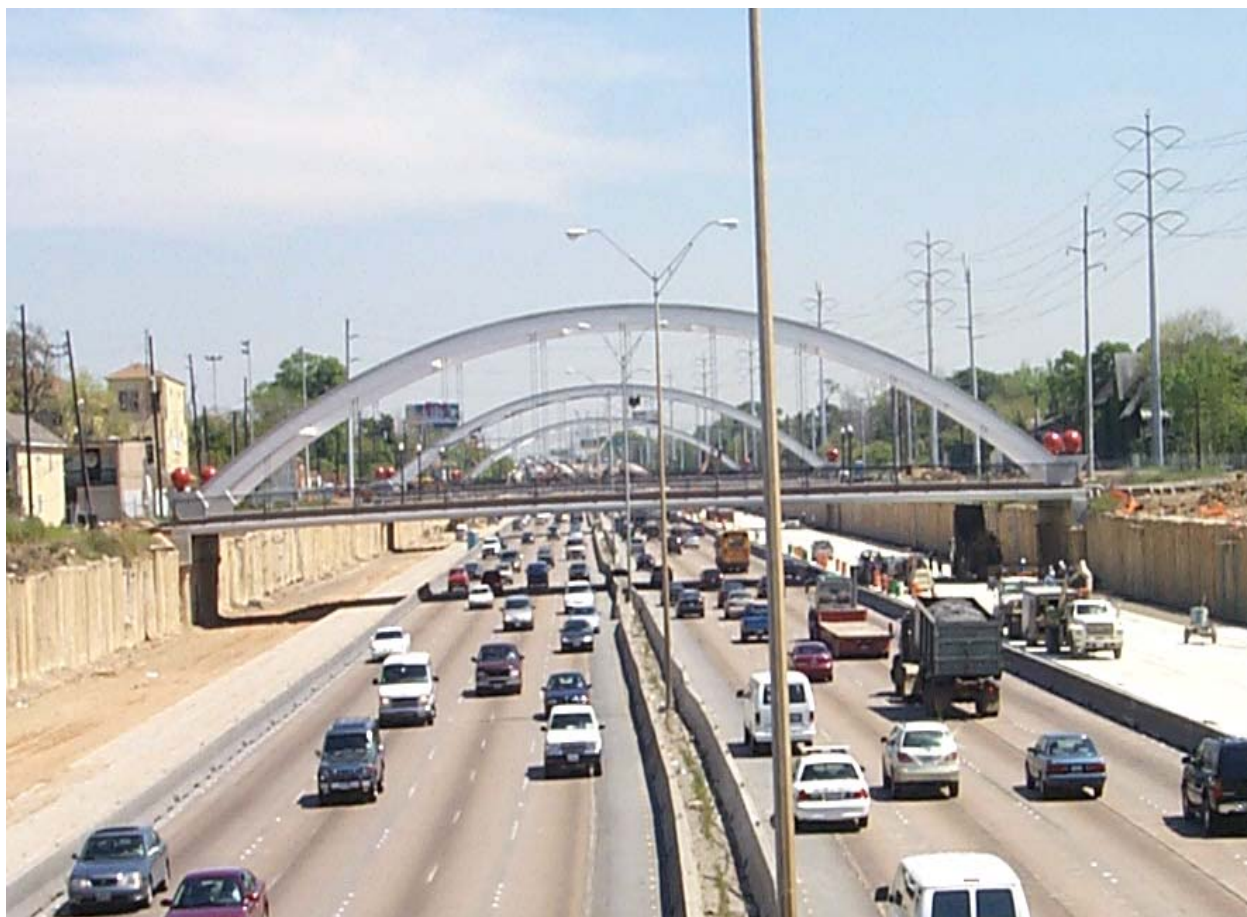
By

**Joe Zietsman, Ph.D., P.E.
Texas Transportation Institute**

Towards a Sustainable Transportation System

- Understanding Sustainable Transportation
- Quantifying Sustainable Transportation
- Applying Sustainable Transportation

Highway 59 On a Good Day



Highway 59 On a Bad Day



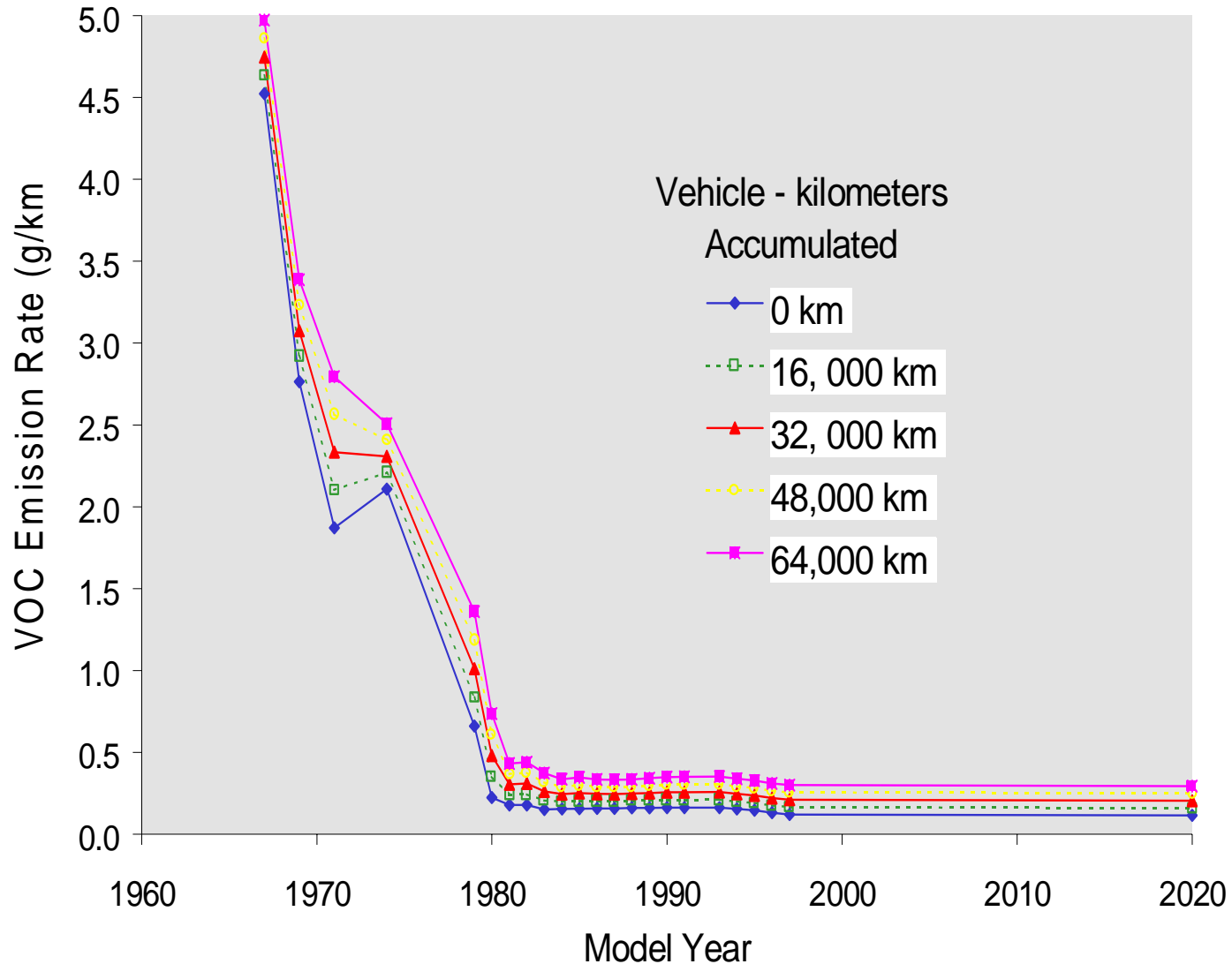
Los Angeles, 1956



Los Angeles, Today



Emissions Versus Model Year



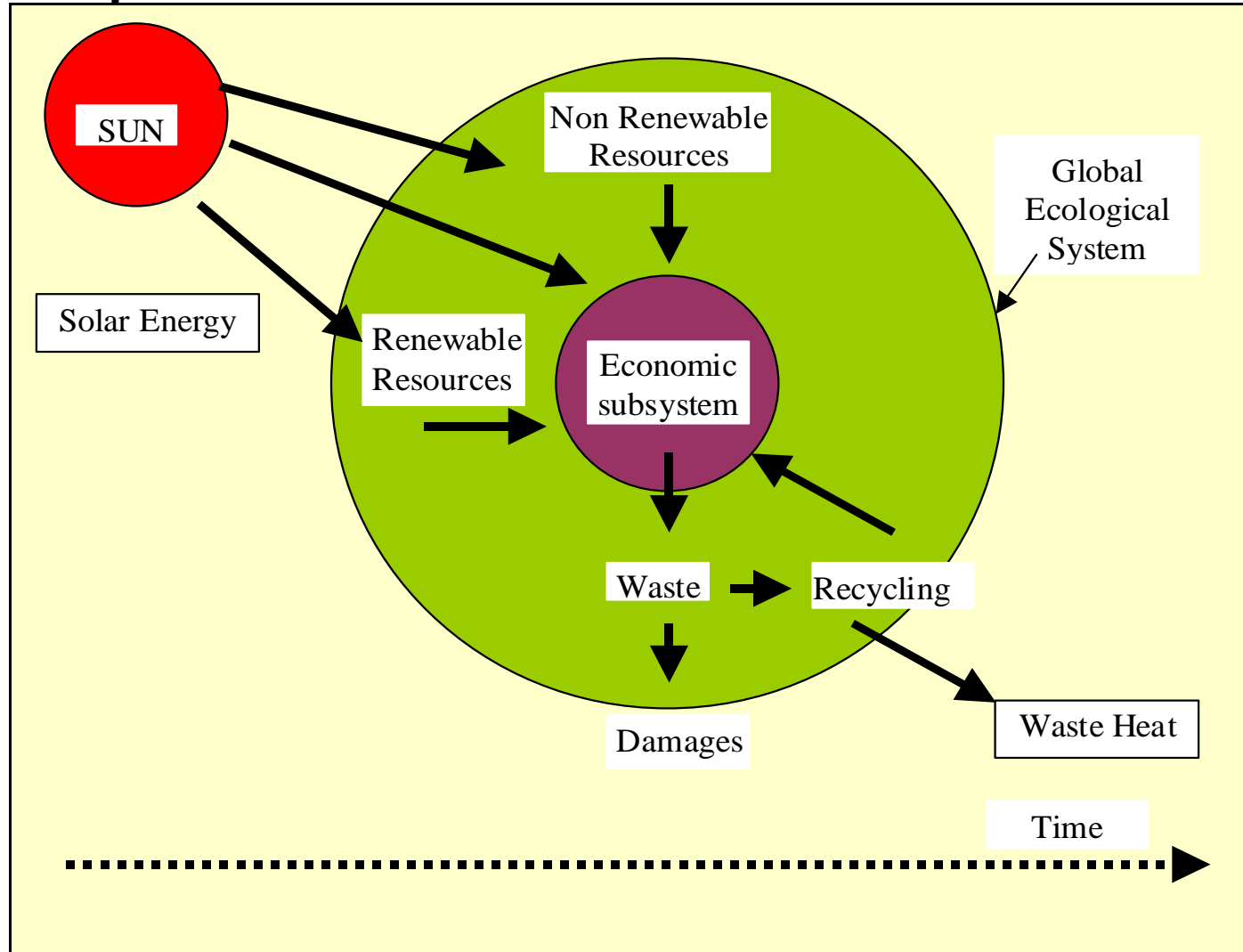


Los Angeles, Without Pollution Controls





Interaction of Economy on Ecological System





Negative Externalities

- Air pollution
- Noise pollution
- Accidents
- Global warming
- Energy use
- Congestion
- Social disruption
- Consumption of land
- Loss of habitat
- Hazardous materials
- Vibration
- Visual intrusion
- Waste disposal
- Water pollution

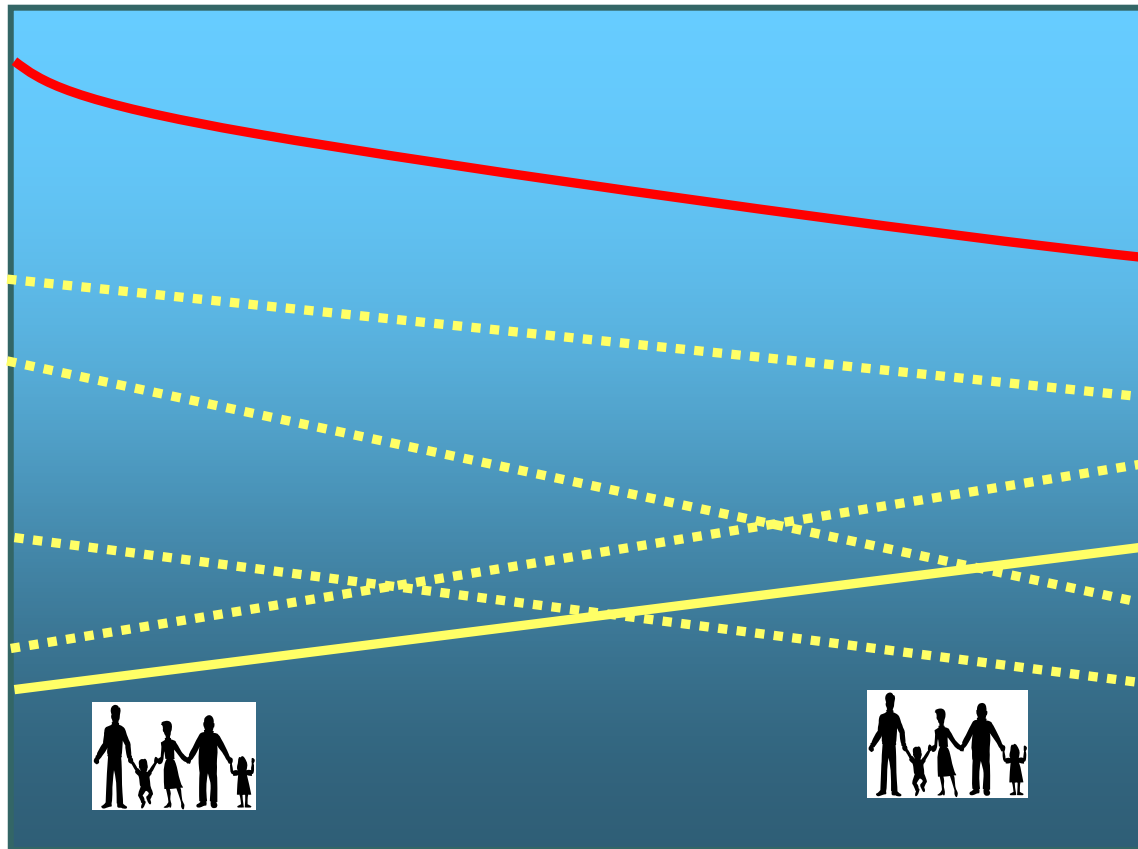
Evolution of Sustainable Development

- **1700's** - Improvement in standard of living = population surge
- **1960's** – Concern over the human impact on the environment
- **1970's** – Specific concerns identified: global warming, acid rain, population growth, and loss of tropical forests
- **1980** – Sustainable Development used as a term for the first time
- **1987** – Brundland Report
- **1992** – UN Conference in Rio de Janeiro
- **2002** – UN Conference in Johannesburg



Defining Sustainable Transportation

Some Appropriate Measure



Sustainability

Resources

Technology

Needs

Environment

Ecology

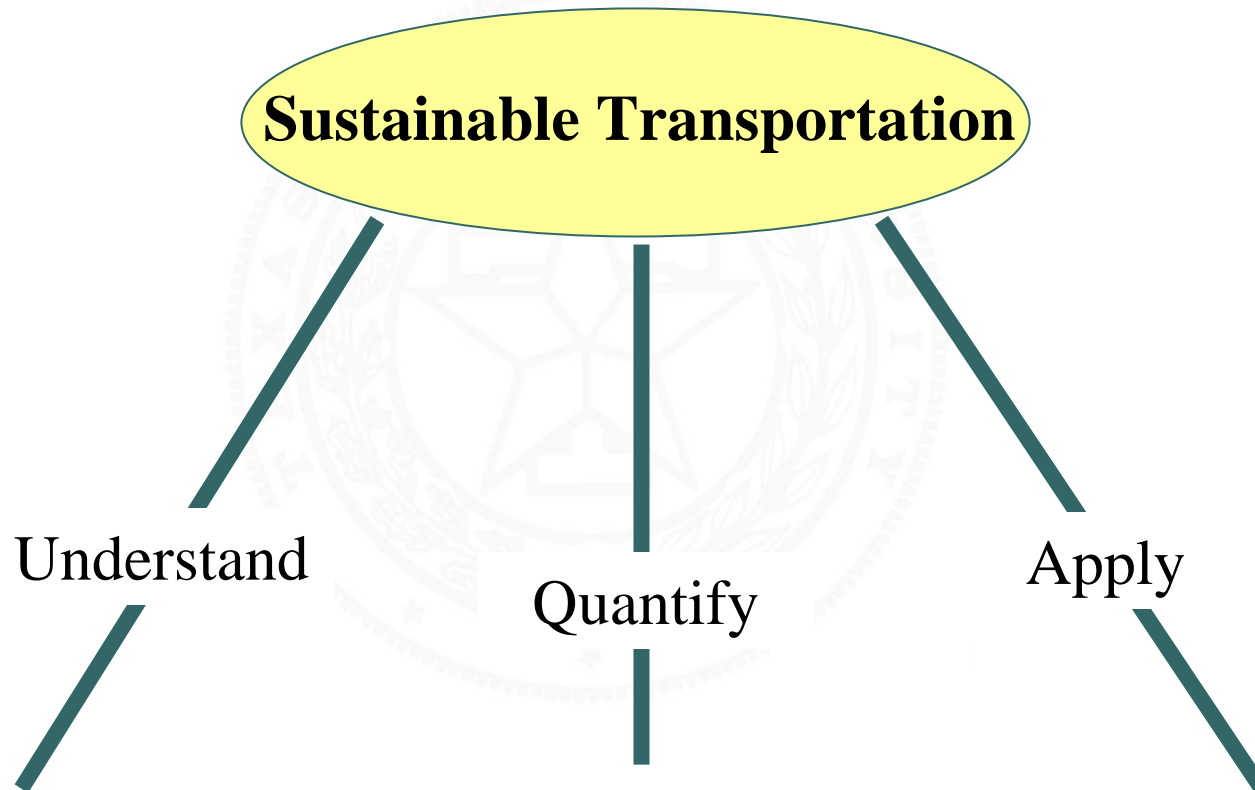
Time →

Defining Sustainable Development

Sustainable development is development that ensures intergenerational equity by simultaneously addressing the multi-dimensional components of economic development, environmental stewardship, and social equity. It is a dynamic process, which considers the changing needs of society over space and time. Sustainable development can be viewed as a continuum, representing various degrees of sustainability. It must, however, be achieved within resource, environmental, and ecological constraints.



Key Challenges for Sustainable Transportation





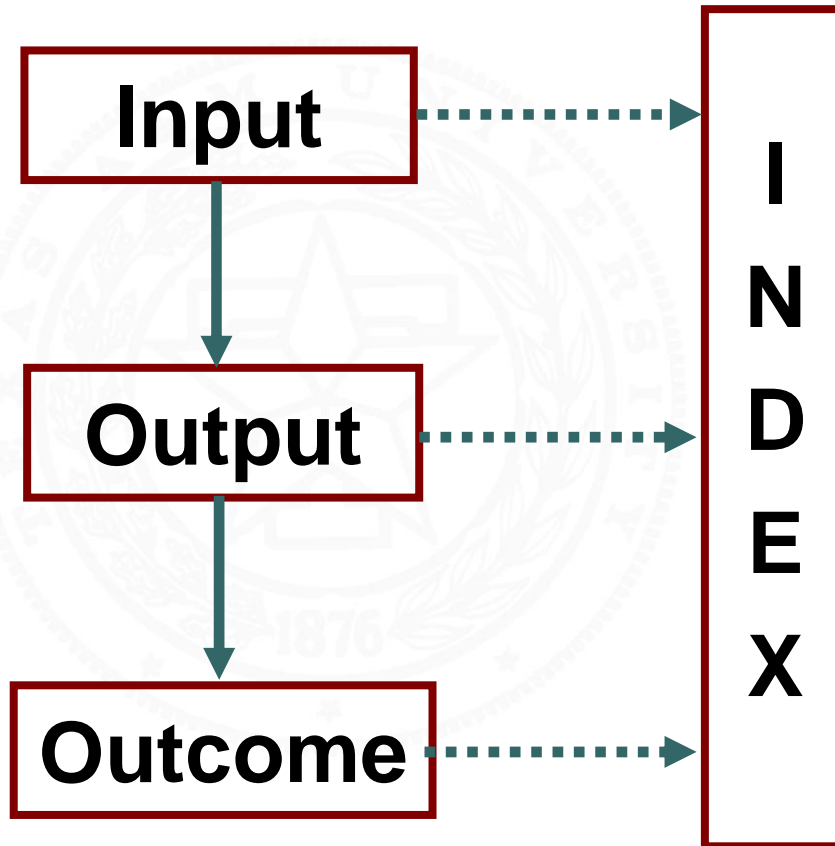
Performance Measures

- **Simplify**
- **Quantify**
- **Communicate**





Categories of Performance Measures





Attributes of a Good Performance Measure

- Acceptable
- Affordable
- Measurable
- Relevant
- Sensitive
- Show trends
- Understandable
- Benchmark

Old and New Paradigms

- 
1. Zoning
 2. Speed
 3. Mobility
 4. Supply
 5. Output
 6. Efficiency
 7. Process
 8. Activities
 9. Aggregate
 10. Bottom-up

1. Integration
2. Mobility
3. Accessibility
4. Demand
5. Outcome
6. Effectiveness
7. Product
8. Results
9. Disaggregate
10. Top-down

TxDOT Goals

Dimension	Goals
Social	Reduce Congestion
	Enhance Safety
Economic	Expand Economic Opportunity
	Increase Value of Transportation Assets
Environmental	Improve Air Quality

Goals of Other Areas - Pretoria, South Africa



Goals

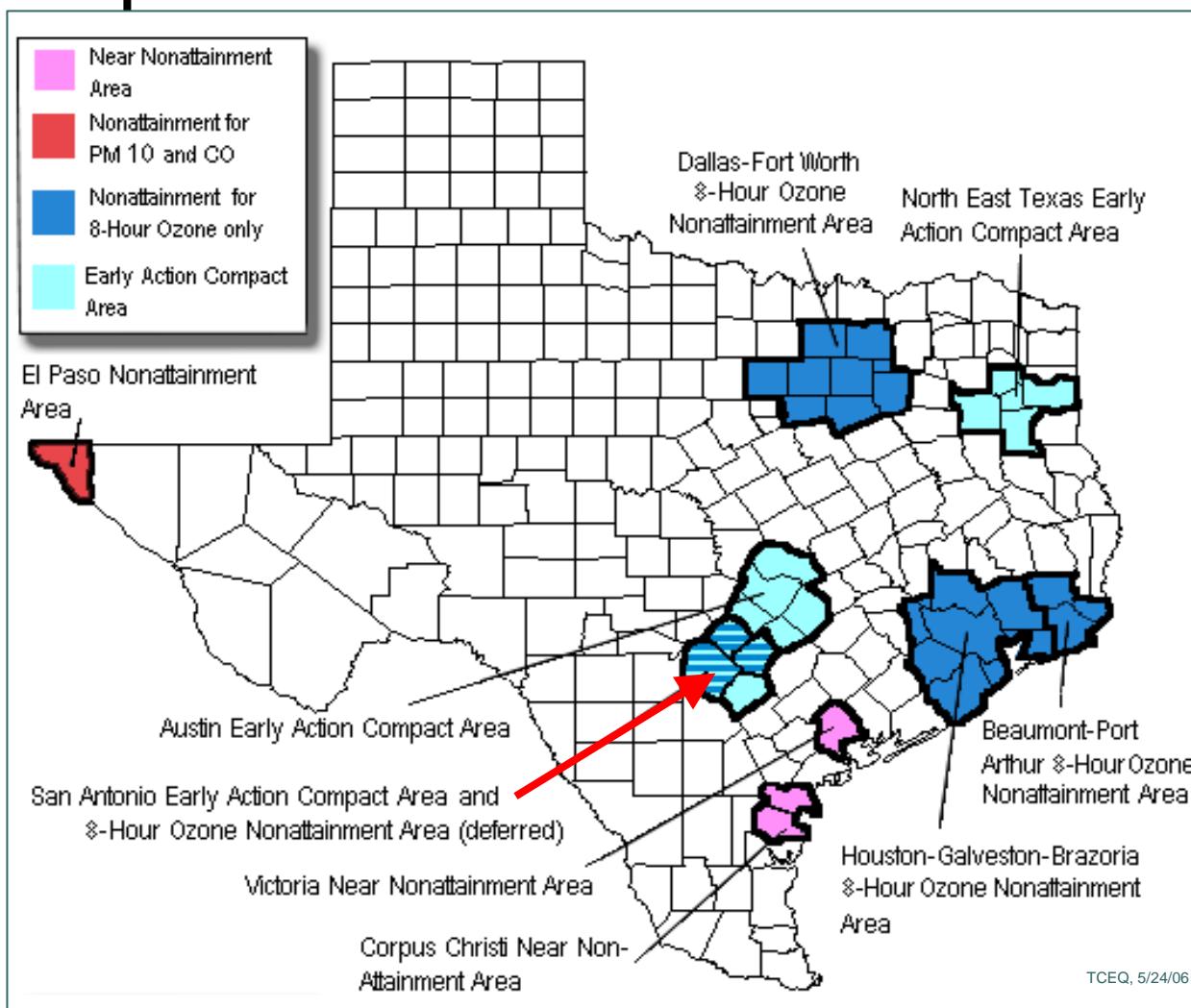
Pretoria Corridor

- Improve mobility and accessibility
- Safety and security
- Economic growth
- Protect the environment
- *Integrate LU and TRP*
- *Regulate transit*

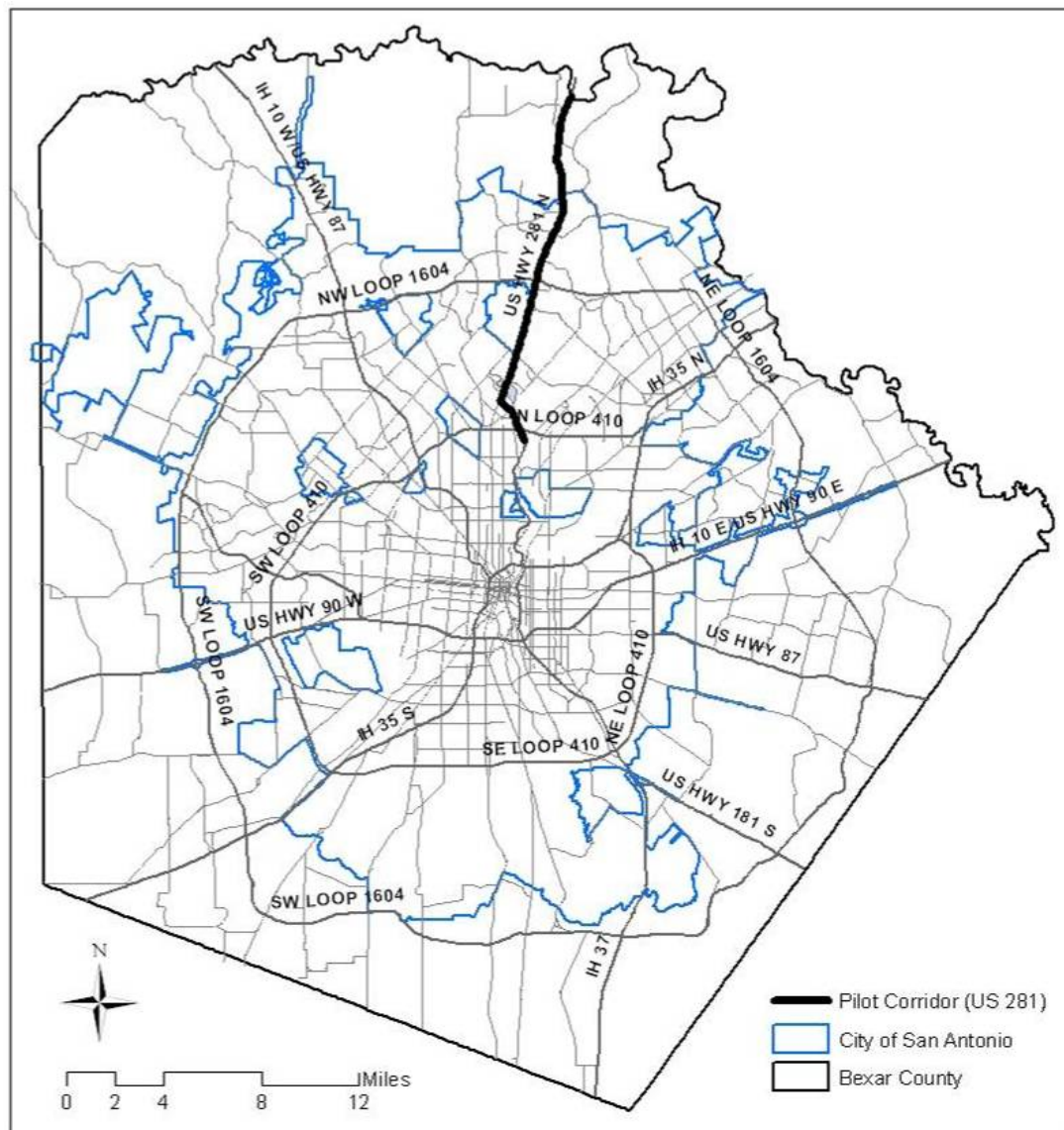
Houston Corridor

- Improve mobility and accessibility
- Safety and security
- Economic growth
- Protect the environment
- *Integrate LU and TRP*
- *Multi-modal system*
- *Conserve energy*

Texas Showing Nonattainment Areas



Test Corridor



Goals and Performance Measures

Goal	Performance Measures
Reduce Congestion	Travel rate index
	Buffer index
Enhance Safety	Annual number of crashes per lane mile
	% lane-miles under TMC surveillance
Expand Economic Opportunity	% of project funding from alternative sources
	% of land within ½-mile of corridor that is zoned as commercial or industrial
Increase Value of Transportation Assets	TxDOT's Pavement Condition Rating (on scale of 1-100)
	% of lane-miles that can be added in median
	Whether toll-eligible project is being tolled
Improve Air Quality	Daily NO _x , CO, and VOC emissions in grams per lane mile

Social, economic, environmental



Formulations

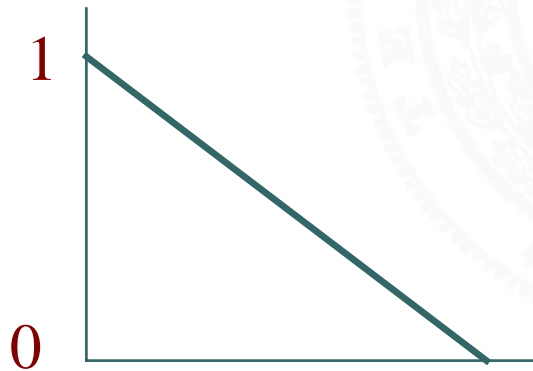
$$TRI = \frac{\text{Peak Hour Travel Rate (Minutes per Mile)}}{\text{Off - Peak Travel Rate (Minutes per Mile)}}$$

$$\text{Buffer Index} = \frac{\text{95th Percentile Travel Time (Minutes)} - \text{Average Travel Time (Minutes)}}{\text{Average Travel Time (Minutes)}}$$

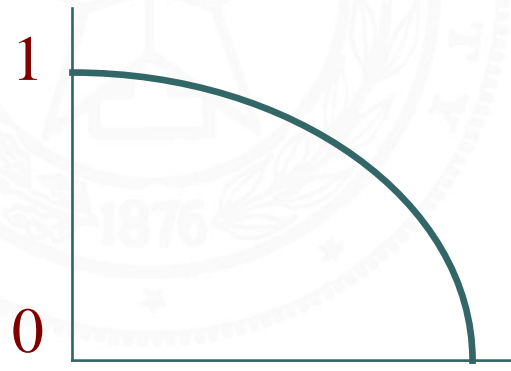
Index Formulation

$$Index = \sum_{i=1}^n Rating_i \times Weight_i$$

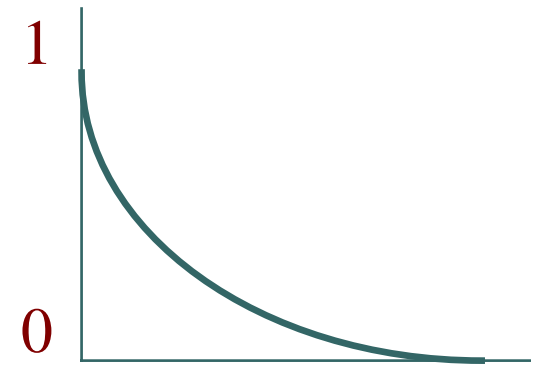
$$Rating_i = f(Normalizer_i)$$



Emissions
Energy use



Safety
Travel cost



Travel rate

Quantified Measures

Performance Measure		Calculated values		Scaling values	
		Base value	Future value	Best Possible Value	Worst Possible Value
Travel rate index		1.60	1.40	1	1.6
Buffer index		0.65	0.58	0	0.65
Annual number of crashes per lane mile		7.94	13.97	0.14	16.5
Percentage of lane-miles under TMC surveillance		0	100	100	0
Percentage of project funding from alternative sources		20	60	100	0
Percentage of land within ½-mile of corridor that is zoned as commercial or industrial		36.08	46.03	50	0 or 100
Daily NO _x , CO, and VOC emissions in grams per lane mile	VOC	28,740	21,350	12,881	39,638
	CO	372,258	292,487	187,102	427,997
	NO _x	83,263	22,637	42,187	96,397
TxDOT's Pavement Condition Rating (on scale of 1-100)		89.2	95.0	100	0
Percentage of lane-miles that can be added in median		28.8	0.0	100	0
Whether toll-eligible project is being tolled		0	1	1	0



Allocation of Weights

Goals	Goal weights	Performance measure	Performance measure weight
Reduce congestion	0.25	Travel rate index	0.65
		Buffer index	0.35
Enhance safety	0.30	Number of crashes per lane mile	0.90
		Percentage of lane miles under TMC surveillance	0.10
Expand Economic Opportunity	0.20	Percentage of project funding from alternative sources	0.40
		Percentage of land within ½-mile of corridor that is zoned as commercial or industrial	0.60
Improve air quality	0.15	Daily NO _x , CO, and VOC emissions in grams per lane mile	0.43 – VOC 0.12 – CO 0.45 – NO _x
Increase Value of Transportation Assets	0.10	TxDOT's Pavement Condition Rating (on scale of 1-100)	0.30
		Percentage of lane-miles that can be added in median	0.50
		Whether toll-eligible project is being tolled	0.20

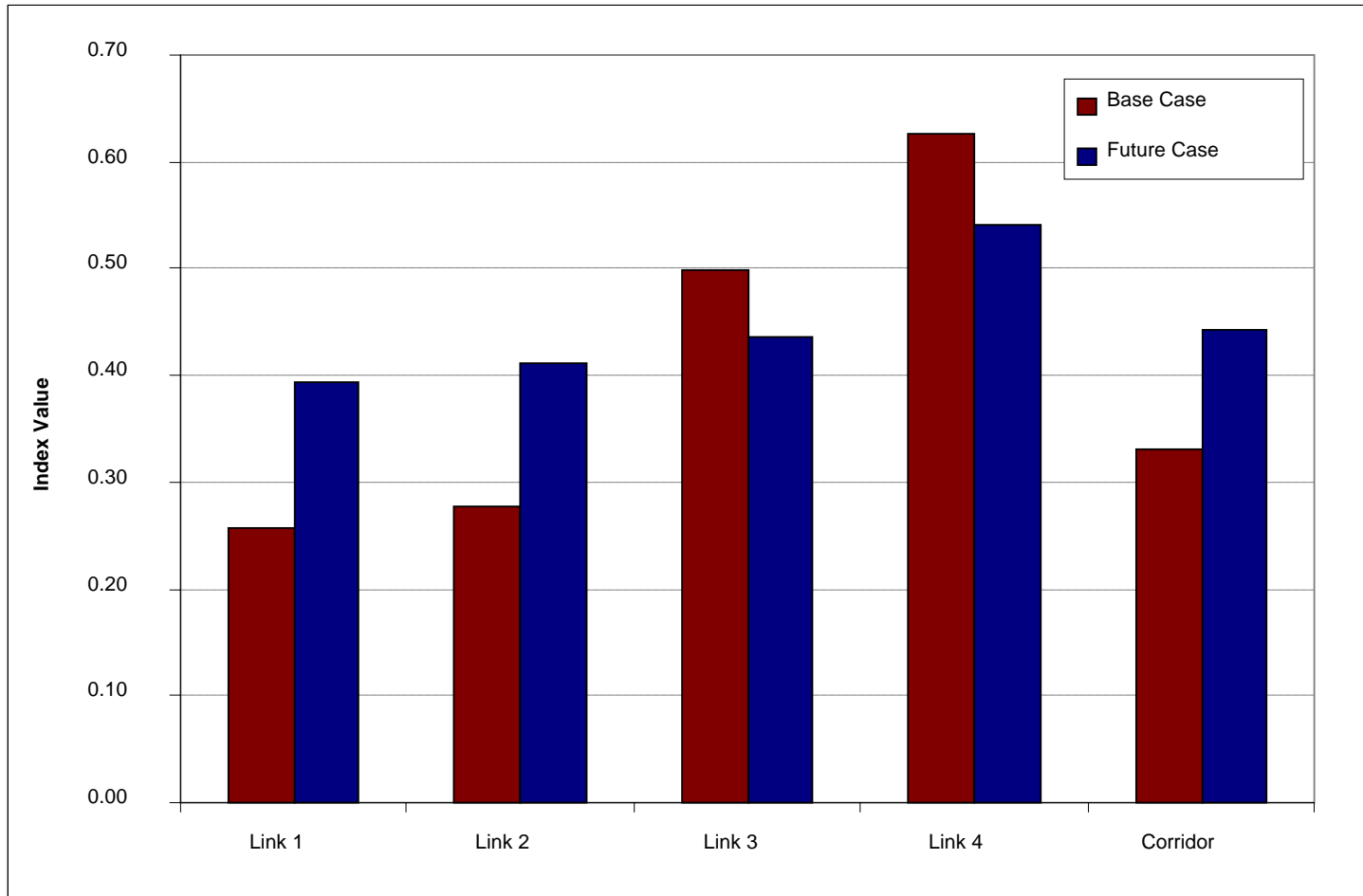


Index Values

Goal	Weight	Un-weighted measures		Weighted measures	
		Base case	Future case	Base case	Future case
Reduce Congestion	0.25	0.00	0.17	0.00	0.04
Enhance Safety	0.3	0.47	0.24	0.14	0.07
Expand Economic Opportunity	0.2	0.51	0.79	0.10	0.16
Improve Air Quality	0.15	0.31	0.81	0.05	0.12
Increase Value Transportation Assets	0.1	0.41	0.49	0.04	0.05
Index values	-	-	-	0.33	0.44



Link-Based Approach





Conclusions

- **Sustainability needs to be:**
 - Understood
 - Quantified
 - Applied
- **Integrate into planning process**