Project Team

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- **Virginia Department of Transportation**
  - Chad Tucker
  - Robin Grier
  - Marsha Fiol
  - Rick Tambellini
  - Ross Hudnall
  - Ben Mannell
  - Brad Shelton
Project Team (cont.)

• Continuing (2011-2012)
  – Junrui Xu
  – Jack Fitzsimmons
  – Philip Rinehart
  – Andrew Watson
  – Zubin George
  – John MacKenzie
  – Natasha Hemminger
Acknowledgments

• University of Virginia

• Commonwealth of Virginia Office of Intermodal Planning and Investment

• Transportation Planning Research Advisory Committee, VCTIR

• Virginia Regions, Planning Districts, and Metropolitan Planning Organizations
  – Jeff Walker
  – Rick Carr

• US Federal Highway Administration

• National Cooperative Highway Research Program
Agenda

Motivation

Goal

Technical Approach

Results

Conclusions
Motivation

• Infrastructure corridors are vulnerable to land development
  – E.g., $5.25 billion Dulles Metrorail expansion
  – Planning and construction complicated by adjacent land uses

• Transportation, energy, telecommunication, water resources, others
Motivation (cont.)

Motivation (cont.)

- 15.2-2222.1: Coordination of state and local transportation planning

- 15.2-2223: Comprehensive plan to be prepared and adopted; scope and purpose

- 15.2-2223.1: Comprehensive plan to include urban development areas

- Multimodal Strategic Plan
  - Performance metrics on land use/transportation
  - Preservation of right of way
  - Locating multimodal facilities
Motivation (cont.)

• National Academies, National Research Council, AASHTO, TRB
  – NCHRP Domestic Scan: Best Practices for Risk-Based Forecasts of Land Volatility for Corridor Management and Sustainable Communities 2011

• Department of Housing and Urban Development, Department of Transportation, and Environmental Protection Agency
  – Partnership for Sustainable Communities 2009 (Environmental Protection Agency 2009)

• American Society of Civil Engineers
  – Report Card for America’s Infrastructure 2010
  – Guiding Principles for the Nation’s Critical Infrastructure 2009
Motivation (cont.)

• Consequences of land development to infrastructure
  • Performance degradation
  • Increased cost of maintenance
  • Increased cost of capacity improvements
  • Human health, safety, and the environment
  • Risk, regret, and belated action

• Economic development and access points increase congestion
  • Corridor sections with existing high density of access points and high traffic can be impossible to adapt
Motivation (cont.)

Transportation planners must address the risks of future land development on various time horizons and geographic scales.
Agenda

Motivation

Goal

Technical Approach

Results

Conclusions
Goal

Priority-setting for multimodal transportation corridors that are vulnerable to land development, and describing the implications for risk management and future investments.
Goal (cont.)

Identify the sections of the 5,700 mile Statewide Mobility System most influenced by the risk of land development in a ten-year horizon.
Goal (cont.)

VTrans Corridors of Statewide Significance
## Project Plan (November 2009)

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Resulting Publications


Resulting Publications (cont.)


Resulting Publications (cont.)


Accomplishments

- **June 2011**
  - Revised final report
  - Made slide presentation to VTrans multimodal committee on this project (Richmond, June 1)
  - Worked as lead author for NCHRP Domestic Scan "Desk Scan" report, contacting DOTs and MPOs across the nation for prospective participation
  - Prepared for first in-person meeting of the Scan team to be held in July 2011
  - Presented latest results to Chad Tucker, Ben Mannell at TMPD and discussed all progress and needs (Richmond, June 6)
  - Submitted revised archival paper to Risk Analysis "Decision Analysis and Risk Models for Land Development Affecting Infrastructure Systems"

- **July 2011 – January 2012**
  - NCHRP Domestic Scan continues
Accomplishments (cont.)

• April 2011
  – Revised and submitted first draft of final VTRC report (April 30, closing of internal UVa account, no more charges)
  – Revised presentation slides
  – Presented paper at 2011 IEEE Systems and Information Engineering Design Symposium
  – Provided TMPD with source files of map data, corridor access-point densities, posters of results

• May 2011
  – Revised final report
  – Participated in telephone meetings of NCHRP 20-68A Domestic Scan 10-01 "Best Practices for Risk-Based Forecasts of Land Volatility for Corridor Management and Sustainable Communities"
  – Presented poster and attended TPRAC meeting (Northern Virginia, May 6)
Accomplishments (cont.)

• **February 2011**
  – February 15, 2011 - Successfully segmented SMS road network files for preliminary access point density analysis
  – February 27, 2011 - Completed access point inventory database of Statewide Mobility System, Corridors of Statewide Significance, and selected parallel corridors. This included 70,000 counted and marked access points

• **March 2011**
  – March 1, 2011 - Sent preliminary analysis sent TMPD, including work completed to date, process, data quality efforts, and heat-map of density.
  – March 2, 2011 - SCAN proposal accepted: NCHRP 20-68A Domestic Scan 10-01 "Best Practices for Risk-Based Forecasts of Land Volatility for Corridor Management and Sustainable Communities"
  – March 24, 2011 - Completed preliminary access point density per-mile analysis, PowerPoint, and GIS files
  – March 25, 2011 - Updated steering committee via WebEx teleconference with latest results analyzing access point densities
Accomplishments (cont.)

• **November 2010**
  – 95% of access points counted
  – Preliminary access point analysis

• **December 2010**
  – December 8, 2010 – Society for Risk Analysis 2010 Annual Meeting
  – Access point maps and charts developed

• **January 2011**
  – January 10, 2011 - Provided map data files related to effort to Michael Baker Corporation at request of TMPD
  – January 28, 2011 - Initiated access point counting effort for Corridors of Statewide Significance and parallel corridors suggested by steering committee (in addition to the already completed Statewide Mobility System access point database)
Accomplishments (cont.)

• **July 2010**
  – Further refined methodology utilizing markov modeling

• **August 2010**
  – August 20, 2010 – Refined methodology and updated charts/maps
  – August 27, 2010 – Steering Committee Update, Richmond, VA
  – August 26, 2010 – Capstone team formed

• **September 2010**
  – September 20, 2010 – Potential access point counting processes analyzed
  – September 30, 2010 – Addition of fuzzy logic to theoretical approach

• **October 2010**
  – October 21, 2010 – Four additional multiple perspective charts/maps
  – October 25, 2010 – Steering Committee Update, Charlottesville, VA
  – October 28, 2010 - Multimodal Strategic Planning Meeting, Richmond, VA
Accomplishments (cont.)

• **April 2010**
  – April 2, 2010 – Identified Bureau of Economic Analysis Bearfacts containing information on personal income trending by region
  – April 8, 2010 – Printed posters with maps showing rankings and preliminary data analysis
  – April 22, 2010 – Steering committee meeting update

• **May 2010**
  – May 14, 2010 - Methodology update using steering committee meeting findings
  – May 25, 2010 - TPRAC May 30, 2010 - Refined methodology to use Census blocks, greater use of NLCD land change data between 1999 and 2001

• **June 2010**
  – June 18, 2010 - Identified new (early 2010 startup) land cover trends project by the US Geological Survey utilizing NLCD data
  – June 28, 2010 - Refined methodology utilizing reliability analysis to predict time to development
Accomplishments (cont.)

- **February 2010 (cont.)**
  - February 9, 2010 – UVA Scholars Lab GIS data transfer
  - February 22, 2010 – VDOT SPS data transfer
  - February 28, 2010 – Updated charts/maps created and analyzed with recently obtained data
  - February 28, 2010 - Developed proposed risk-based decision analysis framework

- **March 2010**
  - March 1, 2010 - Identified and processed relevant elevation data from United States Geological Survey for use in proposed methodology calculations
  - March 5, 2010 - Performed initial ranking analyses of given data in GIS (using home values, population/projections, slopes, landmarks, etc.)
  - March 11, 2010 - Final revisions completed for Transportation Research Forum conference paper
Accomplishments (cont.)

• December 2009
  – December 15, 2009 – Transportation Research Forum abstract submitted
  – December 10, 2009 – Identified NASA Landsat satellite imagery
  – December 31, 2010 – Transportation Research Forum conference paper prepared

• January 2010
  – January 11, 2010 – Identified land use satellite imagery through the National Land Cover Database
  – January 13, 2010 – Meeting with UVA Scholars Lab – Charlottesville, VA
  – January 20, 2010 – Initial charts/maps created for analysis
  – January 30, 2010 – Data requirements and availability list completed

• February 2010
  – February 3, 2010 – Identified Virginia population projections from the Virginia Workforce Connection using data received from the US Census estimates.
  – February 5, 2010 – Preliminary home value and real estate trending data extracted from Citydata.com
Accomplishments (cont.)

• **September 2009**
  – September 17, 2009 – Project Initiation Meeting – Charlottesville, VA
  – September 29, 2009 – Project Initiation Meeting – Charlottesville, VA

• **October 2009**
  – October 6, 2009 – Initial VDOT SPS data transfer
  – October 9, 2009 - Virginia Section Institute of Transportation Engineers – Wintergreen, VA
  – October 22, 2009 - Preliminary Data Meeting – Richmond, VA
  – October 29, 2009 - TPRAC Update – Charlottesville, VA

• **November 2009**
  – November 10, 2009 – Developed proposed methodology
  – November 13, 2009 - UVA Risk Center presentation of proposed methodology – Charlottesville, VA
  – November 13, 2009 – SCAN proposal submitted to FHWA/AASHTO
  – November 30, 2009 - Identified Geodata.gov containing GIS maps from various government agencies
Agenda

- Motivation
- Goal
- Technical Approach
- Results
- Conclusions
Background

- Factors that influence land development
  - Distance from roads (county roads, highways, streets)
  - Distance from bodies of water
  - Distance from city centers
  - Agriculture density
  - Distance to recreation
  - Population
  - Population Projections
  - Housing units/population ratio
  - Soil type
  - Slope

Sources: Pijanowki 2003, Thekkudan 2008
Background (cont.)

- Importance of proactive protection
  - Avoiding costly retrofits
  - Access management
  - Preserving arterial capacity
  - Minimizing disruption of nearby entities

- Example of related efforts
  - Land cover forecasts (SLEUTH)
  - Combines satellite imagery with NASA data in US Geological Survey Model
  - Simulate future impact of future land use policy scenarios
Technical Approach

1. Economic perspectives
2. Geographic perspectives
3. Community perspectives

Priority score for risk of future land development

- Evaluate alternative methodologies
- Collect data set
- Identify vulnerable land areas

Identify high-priority areas for resource allocation
Sources of Data

Diverse agency sources for quantitative and qualitative databases
Sources of Data (cont.)

- Virginia Employment Commission population forecasts
- Landsat/NLCD satellite imagery elevation and land use
- Census TIGER population and housing
- City-data land value
- HUD Housing Affordability
- SOCD Building Permits
- Virginia Workforce Connection population and employment projections
- Small Business Administration HUBZones
- Conserved, protected, and federal lands
- City-data home age
- Property crime
- Distance from intersections
- Employment centers
- Others
Factors that Contribute to Risk of Adjacent Land Development

- Access Points
  - Population Forecast
  - Commercial Land Values
  - Employment Centers
- Public Transportation
  - Population
  - Undervalued Land
  - Efficiency Potential
- Infrastructure
  - Right of Way Costs
  - Time and $ Operation
  - Legal Fees
  - Access Mgmt

Decision
Uncertainty
Objective

Financial Costs And Opportunities
Factors (cont.)
Factors (cont.)

Time horizons for the states of adjacent land development
Factors (cont.)

Risk mitigation

Potential for Development

Planning Agencies

Localities

Private Developers
Developed Inventory of Existing Access Points
Access point locations are marked and counted for corridor segments.
Inventory of Access Points (cont.)

Trees and other objects may block view of access points.
Inventory of Access Points (cont.)

Clouds may block view of access points for large areas
Access points along 6,000 miles of multimodal corridor
Agenda

- Motivation
- Goal
- Technical Approach
- Results
- Conclusions
Economic Perspective

Land Development Ranking Based on Jobs Housing Balance, Employment Forecast, HUBzones

Source: Virginia Employment Commission, US Census, Small Business Administration
Demographic Perspective

Land Development Ranking Based on Population Density, Population Forecast, Unemployment

Land-Use Perspective

Land Development Ranking Based on Land Value, Suburban/Urban/Rural Classification

Source: City-data.com, Virginia Department of Transportation
Land Development Ranking Based on Population, Home Value, Population Projections, and Jobs Housing Balance

Source: United States Census, Virginia Employment Commission, Virginia Workforce Connection
Land Risk, Access Points, and Traffic

Risk map of future land development adjacent to corridor

Coincidence of access points, traffic, and development potential

Mile Point Along Roadway

Winchester  30  Upperville  60  Fairfax  90

Average Daily Traffic (000)

Access Points Per Mile

50

US 50
Crescent Corridor (US 11)
Eastern Shore Corridor
(US 13)
East to West Corridor
(US 60 & US 250)
Heartland Corridor
(US 460)
North Carolina to West Virginia Corridor (US 220)
Northern Virginia Connector Corridor
(US 29 & US 50)
Southside Corridor
(US 58)

Mile Point Along Roadway

Access Points Per Mile

Average Daily Traffic
Tidewater Corridor
(US 17)
Washington to North Carolina Corridor (US 1)

Mile Point Along Roadway
Western Mountain Corridor
(US 52)
Access Points

Top 10% density among all One-Mile Segments
Access Points (cont.)

![Graphs showing number of segments per mile for US 11 and US 29.](image)

Access Points per Mile

- **US 11**
- **US 29**

Number of Segments

2 6 10 14 18 22 26 30 34 38 42 46 50 54 More

Access Points per Mile

2 6 10 14 18 22 26 30 34 38 42 46 50 54 More
Access Points (cont.)

Top-5% Segments (for Access Point Density)

Count of 1-mile Segments

- Staunton
- Hampton Roads
- Richmond
- Northern...
- Salem
- Fredericksburg
- Lynchburg
- Bristol
- Culpeper

Construction Districts
Access Points (cont.)

Count of 1-mile Segments

- Fairfax
- Norfolk
- Sandston
- Luray
- Northern Neck
- Salem
- Williamsburg
- Edinburg
- Petersburg
- Abingdon
- Christiansburg
- Verona
- Other*

Top-5% Segments (for Access Point Density)

Statewide Residencies

*An average segment count for other residencies that appear in the top 5%.
Access Points (cont.)

Top-5% Segments (for Access Point Density)

Count of 1-mile Segments

Corridor Functional Class

Urban Other Principal Arterials
Urban Minor Arterial
Minor Arterial
Major Collector
Other Principal Arterial
Urban Collector
Agenda

- Motivation
- Goal
- Technical Approach
- Results
- Conclusions
NCHRP Scan (April 2011 – February 2012)

• Best Practices for Risk-Based Forecasts of Land Volatility for Corridor Management and Sustainable Communities (NCHRP 20-68A Scan 10-01)

• Sponsored by
  – National Cooperative Highway Research Program
  – Transportation Research Board
  – The National Academies

• Site visits October 2-8, 2011 and October 30-November 5, 2011
NCHRP Scan (cont.)

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- **Matt DeLong**
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- **Tracey MacDonald**
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- **Charla Glendening, AICP**
  Arizona Department of Transportation

- **James H. Lambert, P.E., D.WRE, Ph.D.**
  University of Virginia

- **Shital A. Thekdi, Ph.D. Candidate**
  University of Virginia

- **Michael Wright**
  Arora and Associates, P.C.

- **Melissa (Li) Jiang**
  Arora and Associates, P.C.
NCHRP Scan (cont.)

• Goals of the Scan
  – Identifying corridors that are vulnerable to development
  – Addressing transportation capacity in the development of long-range plans
  – Assessing factors that contribute most to land-use volatility
  – Methods, models, and evidence (data) used to take action
  – Integrating land use and volatility forecasts into transportation plans with a multi-year horizon
NCHRP Scan (cont.)

- 22 agencies and 34 agency representatives contacted
- 5 agencies recommended for Scan visit
- 6 agencies selected as alternatives for Scan visit

[refer to the Desk Scan for details]
NCHRP Scan (cont.)

October 2-7, October 30-November 5, 2011
NCHRP Scan (cont.)

• Milestones
  – February 2011 - Chair and team members identified
  – March 2011 – SME selected
  – April 2011 – Scan conference call (April 12)
  – June 2011 – Desk scan draft completed, drafted itinerary
  – July 2011 – Organizational Meeting of Scan Team, Washington DC (July 14)
  – August 2011 – Final desk scan approved (August 14), host states confirmed, travel arrangements made, draft agenda for scan drafted, ground transport arrangements completed
NCHRP Scan (cont.)

• Milestones (cont.)

  – September 2011 – Briefing materials distributed, pre-scan conference call, scan conducted, thank you letters sent to hosts

  – October 2011 – Draft presentation file submitted, site visit October 2-8

  – November 2011 – Final presentation file submitted, site visit October 30-November 5

  – December 2011 – Draft report delivered to NCHRP and panel

  – February 2012 – Final report delivered to NCHRP
NCHRP Scan (cont.)

- Anticipated Results
  - Forecasting land volatility and corridor development
  - Understanding how transportation improvements are influenced by land development
  - Prioritizing funding allocations to maximize the beneficial effects of land development
  - Protection of suburban and rural corridors and communities
## NCHRP Scan (cont.)

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Adaptability of elicited methods and tools for needs of agencies across the nation
Conclusions

Provided a new capability to manage and track the implementation of access management for multimodal transportation systems.
Conclusions (cont.)

• Results are useful for resource allocation to vulnerable sections of transportation corridors
  – Risk-based strategic decision making
  – Sustainable performance of infrastructure systems

• Flexible methodology applicable to:
  – Large-scale transportation systems
  – Developed and developing areas
  – Several time horizons
  – Various geographic regions
Recommendations

• Recommendation 1 - Risk assessment of land development
  – VDOT Transportation and Mobility Planning Division (TMPD) or contracted researchers should communicate these methods to localities and economic development officials in order to promote concerted efforts towards the protection of the transportation infrastructure.

• Recommendation 2 - Identification of high risk corridor sections
  – VDOT TMPD or contracted researchers should identify corridor sections with high land development rankings as candidates for protective actions in order to avoid regret of unforeseen development.
Recommendations (cont.)

• Recommendation 3 - *Coordination with regions and localities*
  – VDOT TMPD should encourage dialogue with localities/regions on corridor sections where there is a coincidence of features (i) high land-development rankings, (ii) high access-point densities, and (iii) high traffic volumes

  – The dialogue process should encourage regions and localities (MPOs, counties and independent cities) to focus transportation planning efforts on corridor sections with the above features
Recommendations (cont.)

• Recommendation 4 - *Protection actions that support safety, mobility, and economic development*
  – TMPD should use the methods to coordinate protective actions with regions/localities and developers on economic development that avoids to compromise safety and mobility on the adjacent infrastructure corridor

  – Strategy for future development to be considered includes (i) management of access-point densities in the interest of safety, mobility, and economic development, (ii) consideration of proffers to ensure adequate compensation for the impact of land development to the adjacent corridor sections, (iii) investigation for site selection and setback distance directed initially to locations with high land development ranking, high access point densities, and high traffic volumes.
End Presentation

www.virginia.edu/crmes/corridorprotection